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A

MANUAL OF SURGERY.

In Treatises by Various Authors.

IN THREE VOLUMES.

EDITED BY

FREDERICK TREVES, F.R.C.S.,

SURGEON TO, AND LECTURER ON ANATOMY AT, THE LONDON HOSPITAL: HUNTERIAN PROFESSOR AT THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

Volume EE.

THE ORGANS OF LOCOMOTION AND OF SPECIAL SENSE — THE RESPIRATORY PASSAGES — THE HEAD — THE SPINE.

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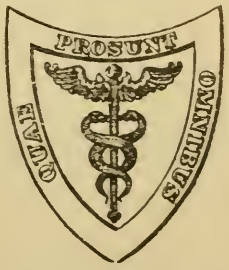

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MANUAL OF SURGERY.

VOLUME II.

I. FRACTURES.

FREDERICK A. SOUTHAM.

A FRACTURE may be defined as the sudden and violent solution of continuity in a bone.

Varieties.—Many different varieties of fracture are met with, and they may, in the first place, be divided into simple and compound. A fracture is said to be *simple*, when it is unaccompanied by an open wound leading down to the broken bone; on the other hand, it is termed *compound*, when there is an open wound which communicates with the seat of fracture. A fracture may be rendered compound at the time of injury by the same violence that causes the fracture, either lacerating the tissues or forcing the end of one of the fragments through the skin; in other cases a fracture, which is at first simple, may subsequently become compound from sloughing or ulceration of the tissues over the seat of injury.

A fracture is said to be *complete* when it involves the entire thickness of the bone, and *incomplete* when it affects a portion only of its thickness; the former variety is by far the more common, the latter being met with in cases where a bone is partially fissured, as is sometimes seen in the vault of the skull, or in the so-called "*greenstick*" fracture (Fig. 1), an injury

often occurring in young subjects, where the shaft of a long bone is bent and partially broken, the fracture only involving the bone on the convexity of the curve; under these circumstances the periosteum often remains untorn, and there is little or no displacement of the fragments. Other forms of incomplete fracture are the *splintered*, where a small portion or splinter of bone is separated, and the *perforated* or *punctured*, the result usually of a gun-shot wound.

A fracture, again, may be *single* or *multiple*; in the former case there is a single line of fracture involving

Fig. 1.—Greenstick Fracture of the Clavicle. (From Pick's "Fractures and Dislocations.")

a single bone; in the latter there are two or more fractures involving either the same or different bones.

When the bone is broken into several or innumerable fragments, the fracture is said to be *comminuted*. A fracture is described as *transverse*, *oblique*, *longitudinal*, *spiral*, T-*shaped*, *stellate*, and *dentate*, according to the direction which the line of fracture takes; it is termed *impacted* when one fragment is driven into and fixed in the other.

When occurring in the neighbourhood of a joint, *e.g.* the hip or shoulder, the terms *intracapsular* and *extracapsular* are employed, according as the line of fracture is internal or external to the capsular ligament. A fracture is said to be *complicated* when it is accompanied by injury to some other important part, *e.g.* by a dislocation or wound of a neighbouring

joint, or by wound of a large blood-vessel, or of some internal cavity or organ; a simple fracture may be complicated by an external wound, the fracture not being termed compound unless the wound in the soft parts leads down to or exposes the bone.

Separation of the epiphyses may be considered along with fractures; these injuries, which occur only in young subjects before ossification is completed, may involve the ends of any of the long bones, the upper and lower epiphyses of the humerus being those which are, perhaps, most frequently separated; less frequently the epiphyses of other bones are involved, *e.g.* those of the os calcis, acromion, olecranon, etc.

Causes.—The causes of fracture may be divided into two great classes, predisposing and exciting.

The *predisposing* causes include all those conditions, constitutional or local, in consequence of which the osseous tissue becomes unusually fragile, weakened, or diseased; *e.g.* old age, rickets, certain nervous affections, such as locomotor ataxy, general paralysis of the insane, etc., caries or necrosis, malignant tumours of bone, osteo-malacia, atrophy of bone from any cause, absorption of bone from pressure of tumours, or syphilis, when the bone becomes the seat of gummatous deposits.

Other predisposing causes of fracture are the male sex, in consequence of their more constant exposure to violence, and the shape and situation of particular bones, the long ones of the extremities being more frequently involved than short, thick bones, like the bodies of the vertebræ, etc.

The *exciting* causes of fracture are external violence and muscular action.

External violence, by far the more common cause, may act in one of two ways, either directly or indirectly. When due to *direct* violence the fracture takes place at the part struck, *e.g.* when a blow on the

nose fractures the nasal bones; under these circumstances, the soft tissues covering the bone are frequently bruised, or torn and lacerated, as the result of the same force that causes the fracture, so that an open wound is produced which leads down to the bone, and the fracture is consequently often compound.

When due to *indirect* violence, the force acting at one spot is transmitted, and causes a fracture at a distance from it, *e.g.* when a person falling upon the hand or shoulder fractures the clavicle.

Muscular action is not a common cause of fracture when the bones are in a healthy condition, except in the case of the patella, which is often broken by the contraction of the powerful quadriceps extensor in an attempt to save the body from falling backwards. Much less frequently some of the other bones, *e.g.* the olecranon, os calcis, etc., are fractured as the result of sudden violent contraction of the muscles inserted into them. When the bones are in a softened or diseased condition, fracture of any of them, even the long ones of the extremities, may be produced in the same way; and, doubtless, most of the so-called *spontaneous fractures* belong to this class, being in reality due to muscular action acting upon bones, which are weakened from some of the causes mentioned above as predisposing to fracture.

In the same way separation of the epiphyses of the long bones is not uncommon in infants the subjects of congenital syphilis, owing to changes of an inflammatory character taking place at the junction of the shafts with the epiphyses; a somewhat similar condition is occasionally met with in children who are affected with "acute rickets" or "infantile scurvy," in consequence of effusions of blood taking place between the epiphyses and shafts, and also beneath the periosteum.*

* Barlow; Med.-Chir. Trans., vol. lxvi., 1883.

Intra-uterine fracture. — Fractures occasionally occur in the fœtus before birth, in some cases as the result of external violence, *e.g.* a fall or blow on the abdomen of the mother; in other instances, in consequence of abnormal contraction of the uterus, or even of the muscles of the child itself. The fracture, which may be either simple or compound, may or may not have united at the time of birth. Intra-uterine fractures must not be confounded with those occasionally produced as the result of violence sustained during actual delivery.

Symptoms.—The general symptoms of fracture are abnormal mobility, deformity, crepitus, and loss of power, with more or less pain, swelling, and ecchymosis at the seat of injury; occasionally the patient is sensible of a distinct crack or snap produced by the giving way of the bone at the moment the fracture occurs.

All these symptoms are not, however, present in every case, being modified by various conditions.

Abnormal mobility is owing to the loss of continuity in the broken bone, and can usually be detected by grasping the limb on either side of the seat of fracture, and then moving the fragments to and fro, or rotating them on one another. It is not, however, a symptom which is always present, for it is wanting in impacted fracture, and cannot, as a rule, be detected when a short or flat bone is broken, *e.g.* in the bodies of the vertebræ, vault of the skull, etc.

Deformity, owing to displacement of the fragments of the broken bone, is, when present, always an important sign of fracture. It may be the direct result of the violence that causes the fracture; *e.g.* in impacted fracture of the lower end of the radius or neck of the femur; or, as is usually the case, it may be due to subsequent muscular contraction; *e.g.* in oblique fracture of the tibia when the lower fragment is drawn upwards above the upper by the action of the muscles

of the calf; or it may be the result of the weight of the limb dragging upon one of the fragments; *e.g.* in fracture of the clavicle, when the outer fragment is drawn down by the weight of the arm. The particular deformity will depend upon the direction of the line of fracture and also upon the nature of the displacement of the fragments; thus it may be angular, or transverse or lateral, or one fragment may override or be rotated on, or widely separated from, the other.

In all cases the injured part should be compared with the opposite side of the body, as it is often only by a careful comparison made in this way that the deformity, if slight, can be detected.

Deformity is not, however, always present; it is often absent when one of two parallel bones is broken; *e.g.* in fracture of the fibula, the tibia, acting as a splint, often prevents any displacement of the fragments from taking place. Again, when a short or flat bone is involved, there is often no displacement and consequently no deformity.

Crepitus is the term applied to the rough grating produced when the ends of a broken bone are rubbed against one another. When present, it is always a valuable sign of fracture, but it is often absent; *e.g.* in incomplete fracture, or when the fragments are impacted, or widely separated, so that they cannot be brought into contact. It is also wanting if a portion of blood clot, muscle, or other tissue, is interposed between the fragments; or if the fracture is not recent, and the ends of the bone have become covered over with inflammatory exudation. When a short or flat bone is fractured, it is often difficult to detect crepitus, as also in cases where one of two parallel bones is broken; *e.g.* in fracture of the fibula.

The true or bony crepitus met with in fracture must be distinguished from false or "silken" crepitus,

as it is sometimes termed, which frequently accompanies inflammation of the sheath of a tendon; in the latter case there is simply a fine crackling very different to the rough grating of fracture. When in the neighbourhood of a joint, care must be taken not to mistake the crackling, which often accompanies effusion into its interior or into an adjacent bursa, for the crepitus of fracture.

Loss of power or *interference with function* is usually present to a greater or less extent in the part where the fracture is situated; more or less *pain* will usually be complained of, and in most instances *swelling* and *ecchymosis* will sooner or later show themselves at the seat of injury.

In cases of *separation of an epiphysis*, the general symptoms are identical with those of fracture, except that crepitus is either absent or much less distinct, owing to the fact that the line of separation runs through cartilage rather than bone; for the same reason, the ends of the fragments are more smooth and rounded, not so sharp and irregular as in fracture.

General principles of treatment.—In the treatment of any fracture there are three indications to be arrived at, and, if possible, carried out, viz.: (1) The reduction of the fracture; (2) the maintenance of the fragments in their proper position until union is effected; (3) the prevention and treatment of any complication, constitutional or local, that may arise.

1. *The reduction or setting of the fracture*, *i.e.* the restoration of the fragments (when displaced) to their proper position, should always be effected with as little delay as possible, otherwise the muscles, as the result of the irritation to which they are subjected, become rigidly contracted, and considerable force will then be required to overcome the spasm. Great care should always be employed in manipulating the limb,

for if it is roughly handled there is a risk of converting a simple fracture into a compound one.

In ordinary cases, *e.g.* in fracture of the long bones of the extremities, reduction is effected by the employment of extension and counter-extension. The surgeon makes extension by drawing steadily and without jerking upon the limb below the seat of fracture, while an assistant makes counter-extension; viz. fixes the limb on the proximal side of the fracture. In this way the extending force, which acts only on the lower fragment, is maintained until the ends of the bone are drawn opposite to one another; by a little manipulation, as, for example, by pressing gently on one or both of the fragments, they can usually be brought into proper position, and some further means must then be adopted in order to maintain them so.

Inasmuch as spasm of the muscles is the chief cause of displacement in fracture, reduction will often be facilitated by the adoption of measures which tend to produce muscular relaxation. In some cases this can be effected by attention to the position of the part; *e.g.* in fracture of the tibia and fibula, by bending the knee so as to relax the muscles of the calf; occasionally division of the tendons may be required before reduction can be effected; *e.g.* tenotomy of the tendo Achillis is occasionally necessitated in the same fracture. Anæsthetics will often be found useful in similar circumstances, for when the patient is under their influence muscular spasm at once disappears.

Reduction is, however, occasionally impossible, as, for example, in certain cases of firmly impacted fracture; under these circumstances it is often better not to attempt it, preparing the patient for the deformity which will be permanent.

2. *The maintenance of the fragments in their proper position* after the fracture has been set has next to be attended to, and this may be effected in various ways;

e.g. by means of splints, bandages, or some form of special apparatus. Splints composed of many different kinds of material are employed for this purpose; *e.g.* wood, tin, zinc, wire, guttapercha, felt, mill-board, leather, etc.

Bandages containing some material, *e.g.* plaster of Paris, starch, gum and chalk, paraffin, silicate of sodium or potassium, etc., which hardens when dry, forming a firm, solid application accurately moulded to the part, are much used at the present time; if necessary, they can be strengthened by the insertion of pieces of iron, tin, felt, or mill-board, between the layers of bandage.

Some surgeons at once put up the fracture in one of the different varieties of solidifying apparatus; *e.g.* a plaster of Paris bandage; others prefer to apply some form of splint, *e.g.* the ordinary wooden ones for a few weeks, and then, when repair is well advanced, to replace them with a stiff bandage.

One great advantage of splints is that the seat of injury can be left exposed, whereas if a stiff bandage is employed the fracture is concealed from view, unless the bandage is interrupted, or slit up along its whole length after it has set, so as to allow of its removal from time to time.

As a general rule, splints should be employed in cases where the soft tissues are much swollen, bruised, or ecchymosed, or where there is much displacement of the fragments and difficulty is experienced in reducing and maintaining them in position, care being taken that in the former case the bandages which fix the splints are not applied too tightly. The seat of injury being left uncovered, some evaporating lotion can be applied, the condition of the part can be examined from day to day without removing the apparatus, and if any displacement of the fragments takes place, it will at once be evident and can then be corrected. If

some form of stiff bandage is applied when the parts are much swollen, it will become loose when the swelling subsides and consequently allow of movement and displacement of the ends of the fractured bone.

A stiff bandage may, however, frequently be applied at once with very good results, if none of the conditions just mentioned are present; and in the case of the lower extremity it possesses this additional advantage, that, being light, it does not necessitate confinement to bed, and the patient, with the assistance of crutches, will often be able to get about in the course of a few days.

Many modifications of the latter method of treatment are now employed, and a very useful one is that recommended by Mr. Croft, in cases of fracture of the lower extremity.* In the so-called "Croft's splints," a double layer of coarse flannel, shaped so as to fit the limb and form a kind of lateral splint, is applied to each side of the leg and foot, the outer layer having been previously saturated with a solution of plaster of Paris and water of the consistence of thick cream. A muslin bandage is applied outside the flannel so as to maintain it in close contact with the limb while the plaster is setting, and at the same time care must be taken that the fracture is kept in proper position. After the bandage has set, it is cut up along its centre, viz. in front of the limb at the line of junction of its two lateral halves, so as to allow of its removal from time to time for the purpose of examining the fracture and the condition of the limb.

In the application of splints there are certain rules which should always be observed; viz. 1. The splints should be well padded, especially where they press upon points of bone. 2. They should, if possible, include the joints above and below the fracture, so as to completely fix the limb. 3. No bandages should be

* Medico-Chir. Trans., vol. lxiv.

applied beneath them. 4. The seat of fracture should be left uncovered. 5. The extremities of the limb, *e.g.* the fingers or toes, should be left exposed to view. When plaster or other forms of solidifying bandages are used, care must be taken not to apply them too tightly, otherwise, when they set, constriction of the limb may be produced; to prevent this, it is a good plan to first envelope the limb in a layer of cotton wool, or to apply dry next to the skin several layers of an ordinary flannel bandage.

Whatever form of apparatus is employed, the fracture should always be examined the day after it has been put up, and subsequently from time to time; if the limb is found to be painful and swollen, and especially if the toes or fingers are cold, numb, congested, or œdematous, the bandages or splints should be eased or removed and re-applied, otherwise there is a risk of gangrene supervening, for the occurrence of these symptoms shows that too much pressure has been used and that the circulation through the limb has become impeded.

The special forms of apparatus which may be required will be mentioned under the different fractures.

The fracture bed, in cases of fracture of the lower extremity, should be flat and firm; if it tends to sink in the centre, a piece of board should be introduced between the mattress and the bedstead. Care should be taken that the sheets do not crease, and, if possible, a strong cord with a short stick attached to its lower end should be suspended over the bed, to assist the patient in raising or moving his body when requisite.

Treatment of compound fractures.—The limb may be put up in a similar manner either in splints or in some form of stiff bandage; if the latter method is employed, an opening, or "window," should be cut in the bandage exactly over the

fracture, or the bandage should be interrupted at the same spot with strips of iron hoop or pieces of strong wire, which are inserted between its layers as it is applied, in order to allow of the wound being examined and dressed when necessary.

As regards the treatment of the wound itself, this will depend upon the nature of the injury.

If there is a mere puncture in the skin caused by the sharp end of one of the fragments, it may often be closed at once with a pad of lint dipped in the compound tincture of benzoin or collodion; under this the wound will often rapidly heal, and the fracture being, as it were, converted into a simple one, will in many cases quickly unite without any suppuration. If, however, under this treatment the temperature rises, and the parts about the seat of fracture become hot, red, painful, and swollen, the pad of lint should be removed, and if there is any evidence of suppuration, the wound should be opened, and free vent having been afforded to the pus, it should be treated in the manner next described, or this method may be adopted from the first.

If the wound is of some dimensions, and if its edges are lacerated and the surrounding tissues much bruised and swollen, no attempt should be made to close it; under these circumstances, if seen within the first twenty-four hours (all bleeding having been arrested), the wound should be carefully cleansed and then thoroughly syringed out with a solution of carbolic acid (1 in 20) or some other antiseptic lotion, care being taken that the fluid comes well into contact with all its recesses. If a longer period has elapsed, a stronger solution should be used, *e.g.* one consisting of carbolic acid and spirit (1 in 5).

Some means must then be provided for efficient drainage; one or more of the ordinary drainage tubes may be inserted, and the wound should be dressed

and afterwards treated according to the Listerian method.

In cases where the ends of the bones are much comminuted, the fragments, when of small size or lying loose and separated from the periosteum, should, if possible, be removed, for if left they will probably necrose. If the wound is small and the bone projects through it, it is sometimes necessary to enlarge the opening before reduction can be effected; and if it is still impossible, the projecting portion of bone should be removed with a saw. When difficulty is experienced in maintaining the ends in apposition, it will sometimes be necessary to bring them together with sutures of silver wire.

The wound must afterwards be treated on general principles, care being taken to prevent any accumulation or burrowing of pus, and the dressing being changed when necessary with as little disturbance of the fracture as possible. In cases of severe compound fracture, amputation of the limb is occasionally required; this is, as a rule, indicated when there is very extensive laceration and destruction of the soft parts with much splintering of the bone, and especially if the main vessels of the limb are wounded, or an adjacent large joint (*e.g.* the knee) laid open. In every instance the age and constitution of the patient should be taken into account, as well as the situation of the injury. A severe compound fracture in a young person of sound constitution may often be successfully treated, whereas in a person advanced in years, or broken down in health, the attempt to save the limb will be useless and often attended with danger to life; so also the prospect of recovery is always much greater in the upper than in the lower extremity, owing to the greater reparative power of the former.

Complications during treatment.—During the treatment of any fracture, various accidents or

complications may arise, some of which are local while others are of a general kind.

Œdema and swelling of the limb are among the most common; they may be due to bruising and extravasation of blood, mingled with more or less of inflammatory effusion, or to simple passive congestion from tight bandaging. Under these circumstances not only does the limb become tense and swollen, but in many instances large blebs or bullæ appear on its surface, containing a clear or blood-tinged serum.

When these conditions are present the bandages should be slackened and some evaporating lotion applied; if the soft tissues are much bruised, the skin should be painted over every day with tinct. benz. co.; when bullæ form, they may be pricked and their contents allowed to escape, or left to themselves, for they generally burst or dry up and disappear in the course of a few days.

Ulceration and sloughing of the soft tissues over the seat of injury may ensue, and as a consequence a simple fracture may become converted into a compound one. *Ulcers* of a troublesome nature are also apt to form over bony prominences, in cases where the splints are not well padded; and unless care is taken, *bed-sores* may also appear over the sacrum, buttock, hips, etc., especially in old or debilitated subjects, when the fracture involves long confinement in the recumbent posture.

Spasm of the muscles of an obstinate nature is sometimes present, and as a consequence considerable difficulty is often encountered in keeping the fracture in proper position. As a general rule, it can be overcome by moderate pressure by means of bandages, though in exceptional cases tenotomy may be required.

Gangrene of the limb is occasionally met with, and, as a rule, it is the result of improper treatment,

e.g. too tight bandaging. Therefore, as already mentioned, the part should be frequently examined, especially during the first few days after the fracture has been put up, and if there is any evidence of coldness, numbness, lividity, or swelling of the limb, or of the fingers and toes, the bandages should at once be relaxed, for if unrelieved gangrene is liable to supervene. Much less frequently gangrene is due to laceration of the main artery of the limb by one of the fragments, or to the vessels being nipped between or pressed upon by the ends of the bone.

Venous thrombosis and embolism are sometimes met with. In most cases of fracture, thrombosis doubtless occurs to a greater or less extent in some of the veins in the neighbourhood of the injury. In rare cases a portion of clot may become detached, and, acting as an embolus, it may be carried onwards by the stream of blood along the large veins until it reaches the heart or one of the branches of the pulmonary artery; there it may become arrested and give rise to sudden death from asphyxia. Fortunately this complication of fracture is very uncommon, but two cases of its occurrence in simple fracture of the lower extremity, and followed by death, have come under my immediate notice.*

Fat embolism is the term applied to a condition met with as a complication of simple, though much more frequently of compound, fracture, in which the capillaries of the lung, kidney, brain, spinal cord, and, in fact, of almost every part of the body have been found plugged with fatty emboli or globules of liquid fat.

It is believed that it may occur to a slight degree in all cases of fracture, but especially so in severe cases accompanied by much crushing of the bone and its medullary cavity, when fluid fat is set free in large

* *Lancet*, vol. i., p. 296; 1879.

quantities. Under these circumstances the oil globules, gaining access into the venous circulation through the openings in the vessels about the seat of the injury, act as emboli and are carried on by the blood stream until they become arrested in the capillaries of the various tissues and organs.

In order to detect their presence, the parts after removal should be stained with osmic acid; the fatty matter will then be evident in the form of black globules and irregular masses of various sizes blocking up the capillaries and minute vessels.

The symptoms of fat embolism are somewhat obscure; they usually come on as a kind of secondary shock from twenty-four to forty-eight hours after the occurrence of the injury, consisting, as a rule, of dyspnœa with irregular action of the heart, and pallor, or cyanosis of the face; occasionally slight hæmoptysis has also been observed; the temperature may be lowered or run somewhat high; in fatal cases the patient rapidly becomes collapsed, and sinking into a condition of coma, death may be preceded either by convulsions or paralysis. When recovery takes place, it would appear that the fatty matter is eliminated by the kidney, for its presence in the urine has been detected for several weeks after the injury.

As regard treatment, it has been suggested that intravenous injections of ether might be of service along with artificial respiration; when cyanosis is a prominent symptom, venesection might possibly give relief.

In cases of compound fracture, other complications are frequently met with. *Necrosis* often results, small pieces of bone, which have been detached or stripped of their periosteum, subsequently dying. *Suppurative periostitis* or *acute osteo-myelitis* with extensive suppuration may ensue, and, as a consequence, large portions of bone may necrose. Under these circumstances

union will be retarded, the presence of the dead bone, which is often long in separating, interfering with the process of repair. *Extensive sloughing of the soft tissues* may also result, and, as in other injuries, *erysipelas* may also attack the wound.

The general complications which are common to all varieties of fracture are as follows: *shock; traumatic delirium*, especially liable to occur in persons of intemperate habits; *hypostatic congestion of the lungs*, often met with in old persons as the result of confinement in the recumbent position. *Retention of urine* for some days after the accident is not uncommon, in some cases as the result of shock, in others in consequence of confinement to bed; *tetanus* may occur as after other injuries, but is a rare complication.

In cases of compound fracture there is, in addition, the risk of *severe traumatic fever*, and this may run on to *septicæmia* and *pyæmia*, complications which frequently prove fatal.

After union has been effected, and the splints have been removed, other complications are frequently met with.

Œdema of the limb is often present for a time, with *stiffness* of the joints above and below the seat of fracture, the latter condition being due to long confinement in a fixed position, and to the formation of adhesions around the tendons and between them and their sheaths. As a rule, these conditions will gradually disappear if the limb is used, and friction with some stimulating liniment employed along with passive movement. If the œdema persists, one of Martin's indiarubber bandages will often be found useful.

Pain about the seat of fracture, of a somewhat rheumatic character, is frequently complained of for a considerable period, especially in the case of old people; this also will, as a rule, gradually disappear in course of time; but when severe and obstinate, relief may

often be obtained by the internal administration of iodide of potassium, and counter-irritation over the seat of fracture by painting with tincture of iodine, or, if much thickening is present, by the application of some mercurial ointment.

Paralysis of the limb is occasionally met with, especially in the upper extremity, as the result of implication of the nerves in the callus which is formed at the seat of fracture; under these circumstances it is sometimes necessary to cut down upon the fracture in order to liberate the nerve.

Crutch paralysis, i.e. loss of power in the arm from the pressure of the crutches upon some of the nerves which supply it, is often met with in fracture of the lower extremity, if the patient is allowed to walk about on crutches without hand-bars, or the arm-pieces of which are not well padded. Any or all of the nerves supplying the arm may be involved; paralysis of the musculo-spiral is perhaps most common, the patient then presenting evidence of wrist-drop.

Shortening of the limb often ensues, in many cases as the result of improper treatment, *e.g.* allowing the ends of the bone to overlap. After separation of an epiphysis it is sometimes met with as the result of actual arrest of growth, the epiphysial cartilage being so injured that the development of the bone is afterwards interfered with.

Morbid growths springing from the bone, and usually of a sarcomatous or cartilaginous nature, may in rare cases develop at the seat of fracture, at a variable period after the injury.

Process of repair.—The uniting material by which union is effected in fracture is termed *callus;* this consists, in the early stage, of simple inflammatory exudation or lymph, and the process of repair in simple fracture is essentially identical with that which occurs

in the healing of wounds by first intention in the soft parts, except that the lymph subsequently develops into bone instead of remaining as ordinary cicatricial tissue. As the immediate result of the injury, more or less extravasation of blood takes place into the tissues round about and between the ends of the bone, the periosteum being torn and the adjacent muscles lacerated to a greater or less extent. Inflammation rapidly ensues, and there is an exudation of lymph into the adjacent parts poured out by the vessels of the bone, periosteum, and surrounding tissues. The consequence is, that between and around the ends of the bone, as well as into the medullary cavity, there is poured out a quantity of plastic matter which mingles with the blood clot already present; in the course of a few days this gradually begins to consolidate, the blood clot becoming either absorbed, or remaining and assisting in forming the callus, the term applied to the uniting medium, as it becomes firmer and fibrous.

At the same time, the periosteum at the seat of injury gradually disappears, becoming lost in the mass of callus, which, as it consolidates, forms a kind of fusiform sheath or natural splint round the ends of the bone.

The term *provisional* or *temporary* callus is applied to that which is poured out around the bone and within its medullary cavity; while that which is formed between the broken ends is described as *definitive* or *permanent* callus.

As the process continues, a new periosteum is formed from the outer or superficial layer of callus, which, after developing into fibrous tissue (and occasionally in children into cartilage or fibro-cartilage), subsequently ossifies and forms new bone, a deposition of lime salts taking place in its substance. This process of ossification usually commences about the end of the first, and is often considerably advanced by the end of the third week

The result is that in the course of four to eight weeks the ends of the bone become firmly united by a mass of newly-formed osseous tissue, which at first is spongy and cancellous, and can often be felt as a distinct swelling surrounding the bone at the seat of injury.

The last stage in the process consists in the disappearance of the provisional callus; this, after becoming dense and compact, undergoes a gradual process of absorption, and in the course of some months more or less completely disappears, so that the bone resumes its natural form, and the medullary canal is restored. By the time this is effected, the permanent callus poured out between the ends of the fragments will have acquired sufficient strength to maintain the continuity of the bone; hence it would appear that it is the function of the former to support the fragments and to keep them in apposition, in fact, act the part of a temporary splint, until union is effected.

The amount of provisional callus which is formed depends upon the nature of the fracture and also upon its after-treatment. If there is no displacement nor comminution of the fragments, and if they are kept in a state of complete rest, it may be entirely absent. If, however, they are much splintered, or not in perfect apposition, or if some movement is allowed, then it is often considerable in amount, being poured out around the splinters or ends of the bone. In fracture of certain bones, *e.g.* the ribs and clavicle, provisional callus is, for obvious reasons, always present, and, as one would expect, it is more frequently met with in children than in adults, owing to the difficulty often encountered in the former in keeping the fracture completely at rest.

In the case of *compound fractures*, when the external wound, being of small size, is at once closed

or sealed, and the fracture is, as it were, converted into a simple one, repair may take place in a similar manner.

In many cases, however, and especially when the wound is large and accompanied by much laceration of the soft tissues or splintering of bone, union is effected by a process of suppuration and granulation, identical with what occurs in healing by second intention in the soft tissues. Suppuration is excited at the seat of injury, and granulations spring up from the ends of the bone, as well as from the adjacent soft parts; the consequence is that the whole of the interior of the wound becomes lined with a layer of granulation tissue secreting pus, which bathes the ends of the bone.

By the growth and development of these granulations into fibrous tissue the cavity of the wound is gradually filled up, and at the same time union is effected. The subsequent changes are identical with those which occur in simple fracture, the fibrous tissue undergoing a process of ossification, so that the ends of the bone become surrounded and united by a mass of callus, which, after developing into bone, is more or less completely absorbed, and disappears.

The process is, however, frequently complicated by necrosis; small portions of bone, which have been separated at the time of injury, or had their supply of blood interfered with, often die; or the ends of the bone themselves, having been stripped of the periosteum, or injured to such an extent that their vitality is destroyed, may subsequently necrose.

Under these circumstances the wound will not heal so long as the dead portions of bone are present, for, acting as sources of irritation, they keep up suppuration. If of small size, they may make their way externally; but when of some dimensions, it will often be necessary to enlarge the wound and extract

them with a pair of forceps. When the ends of the fragments themselves necrose, the process is usually a very tedious one, for then separation is slowly effected, the dead portions of bone often becoming ensheathed by new osseous tissue thrown out round about them; under these circumstances they will frequently have to be removed by the operation of sequestrotomy.

The *length of time* required for union varies in the different bones, and also depends upon the nature of the fracture and the age of the patient. In simple fractures of the lower extremity occurring in healthy adults, the average period is from eight to twelve weeks; in the case of the upper extremity, from four to eight weeks. In the case of children, where union is more quickly effected, the time required is somewhat shorter, while in old persons it will be longer.

In severe compound fractures the period will often be three or four times that required in simple fracture.

Defects in the process of union.—The process of repair may in certain cases be delayed beyond the usual period, and occasionally it is not effected by means of bone, or does not take place at all; under the latter circumstances the fracture is said to be ununited.

Delayed union may be due to any of the causes mentioned below as giving rise to non-union.

The treatment is partly constitutional, partly local. Attention should be paid to the general health, and an attempt made to promote union by stimulating the reparative process, *e.g.* by rubbing the ends of the bone gently together; shampooing the limb around the seat of fracture; "hammering" the limb, *i.e.* surrounding it with a piece of felt, and then percussing it forcibly with a mallet over the seat of fracture; blistering the limb, or painting with tincture of iodine over the same spot, etc.

In cases where the patient has been confined to bed

in splints for the usual period, union often results if he is allowed to get about on crutches with the limb in a stiff bandage. When the fracture has not been kept in a state of complete rest, repair will often take place if it is put up in some immovable apparatus.

Non-union may appear under three different forms.

1. In *ligamentous union*, the most common variety, the ends of the bone are merely united by fibrous tissue, so that a certain amount of movement is possible between them.

2. In *false joint*, or *pseudarthrosis*, a somewhat similar condition is present, but the movement is more free, the ends of the bones becoming smooth, rounded and enclosed in a kind of capsule formed of fibrous tissue, not unlike that of a joint. In well-marked cases their surfaces, of which one is often convex, the other concave, may be invested with a layer of imperfect cartilage and lubricated by a serous secretion resembling synovial fluid.

3. In *true non-union* the ends of the bone are quite separate, there being an entire absence of any uniting material.

The *causes* which may give rise to these conditions are both constitutional and local.

The *constitutional* include all those conditions which, by inducing a low state of health, interfere with the healthy nutrition of the tissues, and, consequently, with the process of repair, *e.g.* various acute affections, such as fevers, syphilis, the cancerous cachexia, phthisis, scurvy, chronic kidney disease, etc. Old age, pregnancy, and lactation are sometimes said to interfere with union, but as a rule their influence is very slight.

The *local* causes are also various.

Mobility of the fragments is probably the most common. This may be due to the splints or bandages

being applied too loosely, or in consequence of their removal before repair is completely effected.

Separation of the fragments is another cause of non-union. This may be due to muscular action, as in the case of the patella, or to interposition of a portion of muscle or tendon between the ends of the bone. In cases of compound fracture, non-union is often due to actual loss of bone, removed either at the time of injury, or subsequently for necrosis. Interference with the circulation of the blood may also prevent repair from taking place; *e.g.* non-union is apt to occur in cases where the nutrient artery of the bone is injured by the line of fracture running through it; or where blood is not freely supplied to both fragments, as in fracture of the neck of the humerus or femur; or, again, in cases where a congested and œdematous condition of the limb is produced as the result of tight bandaging, or from extensive bruising of the soft parts accompanied by venous thrombosis.

The *treatment* is partly constitutional, partly local. As regards the former, attention should be paid to the general health, and any constitutional condition which is present should be treated on ordinary principles.

As regards local treatment, measures similar to those recommended in the case of delayed union (page 22) should be tried, and if they fail, more vigorous ones should be adopted, the object being to set up a more active inflammation at the seat of injury.

This may be attempted in various ways; *e.g.* by the introduction of acupuncture needles, or of a seton between the ends of the bone, by the subcutaneous division with a tenotome of the fibrous tissue which unites them; by electro-puncture; or by the injection of some stimulating liquid in the neighbourhood of the fracture.

If these methods prove unsuccessful, the ends of

the bone should be exposed, and one or other of the following plans adopted: ivory pegs are driven into holes bored in the bone with a drill; or the ends of the bone are removed with a saw (the periosteum being as far as possible preserved) and the fragments then brought together by metallic screws or sutures of silver wire. The latter method, "wiring the fragments," is commonly adopted, and as a rule with good results, the sutures being either removed after several weeks or cut short and left permanently. When non-union is due to actual loss of osseous tissue, as in some cases of compound fracture, attempts have been made to fill up the gap by transplanting bone.

When operative treatment has proved unsuccessful, and the limb is useless and an encumbrance to the patient, amputation may be indicated, but even under these circumstances, and especially in the upper extremity, some form of apparatus can often be adapted to the part, so that, though its usefulness is much impaired, it will, nevertheless, prove much more serviceable than an artificial limb.

Union with deformity.—Union is sometimes accompanied by considerable deformity, and the function of the limb is in consequence seriously impaired. This condition, "vicious union," as it is often termed, may be owing to restlessness of the patient, or to unskilful treatment, *e.g.* imperfect reduction of the fracture; improper application of splints, in consequence of which the fragments are not kept in position or at rest; removal of the splints before union is completely effected and subsequent yielding of the callus, etc. Under these circumstances, union is often accompanied by considerable projection of one or both fragments. Another form of vicious union is seen in cases when two contiguous bones become united by callus thrown out between them, *e.g.* in the fore-arm, leg, or ribs; this deformity is, however, of little

importance except in the fore-arm, when the movements of pronation and supination become interfered with.

The *treatment* will depend on the nature of the deformity and the length of time which has elapsed since the fracture occurred. When there is projection of the fragments and the callus is not yet firmly ossified, the deformity will often gradually disappear under firm pressure properly applied by well-padded splints, or the limb may be forcibly straightened at once under anæsthesia. If, however, a considerable period has elapsed, and firm bony union has taken place, it will often be necessary to refracture the limb either by manual force, or by the employment of a strong clamp, known as the osteoclast.

In other cases, before the bone can be straightened, it may be necessary to divide it subcutaneously, or remove a wedge-shaped piece of bone from the projecting angle. The sharp end of one of the fragments, if projecting beneath the skin, may be treated as an exostosis and sawn off, but it will usually be found that, if allowed to remain, it will wear down and become rounded off, so that in course of time it will often gradually disappear to a great extent. The limb, after it has been straightened by any of these methods, should be put up again in splints and treated as a recent fracture, care being taken to prevent any recurrence of the deformity.

Wounds of bone are closely connected with compound fractures. It will, however, sometimes happen that a kind of incised wound is produced, the periosteum and a portion of the thickness of a bone being divided as the result of a blow with some cutting instrument. Punctured wounds have already been referred to, and gun-shot wounds are discussed in the chapter on that subject. As the injury to the bone is always accompanied by an open wound, the general

treatment will be identical with that of compound fracture.

Contusions of bone are of common occurrence, being often met with in those that are superficial and exposed to external violence, *e.g.* the subcutaneous surface of the tibia, vault of the skull, etc. The injury is often followed by inflammation of the periosteum, evidences of which will be present, and when the process is limited, the localised swelling, which frequently results, is described as a "traumatic node."

In other cases, *e.g.* as a result of a fall on the hip, the cancellous tissue of the neck of the femur may become more or less bruised or contused; inflammatory changes of a subacute or chronic nature may subsequently ensue, occasionally followed by an interstitial absorption of the osseous tissue, in consequence of which the limb may become permanently shortened.

Special Fractures.

THE FACE.

Nasal bones.—Fracture of the nasal bones is often produced as the result of direct violence, *e.g.* a fall or blow on the nose; it is in consequence usually attended by bruising or laceration of the soft tissues, and in many cases considerable swelling, sometimes accompanied by emphysema, speedily sets in, so that unless seen soon after the receipt of the injury, the detection of the fracture may be somewhat difficult.

The fragments may be displaced backwards, or to one side, the bridge of the nose being in consequence either flattened or deflected laterally. If the fracture also involves the *lachrymal bone* there may be obstruction to the flow of tears, and epiphora, owing to injury to the lachrymal sac or nasal duct.

Fracture through the septum nasi, or separation from its attachment to the vomer, may occur alone, or

accompany a fracture of the nasal bones; in some cases the cartilaginous septum is simply bent to one side, giving rise to a troublesome and characteristic deformity.

Treatment.—When any displacement of the fragments is present, an attempt should be made to correct it as speedily as possible, for if allowed to remain, union rapidly takes place, and considerable difficulty will afterwards be experienced in treating the deformity.

This can usually be effected by means of an ordinary pair of polypus forceps, introduced into the nostril; on using them as a lever, or on separating the blades, the displaced fragments can usually, with a little manipulation, be guided back into the normal position, especially if the patient is anæsthetised. When once replaced, they will often remain so; if, however, there is any tendency for the displacement to return, it can sometimes be prevented by the patient wearing in the nostril a short piece of gum-elastic catheter, or some form of plug.

When the nose is bent to one side, it may be necessary to make lateral pressure from without, and for this purpose Adams's "nose truss," consisting of a pad adjusted by cog wheels and attached to a steel band which passes round the head, will often be found useful.

When the septum is deflected, it can usually be straightened under anæsthesia, by means of Adams's forceps, a pair of strong forceps with flat parallel blades, and at the same time the nasal bones, if depressed, can also be raised. As there is generally a tendency for the deflection to recur, the patient should for a time wear some apparatus to retain the septum in position, *e.g.* Adams's steel screw compressor, or an ivory plug.

Upper jaw and malar bone.—Fracture of

the upper jaw is sometimes met with as the result of direct violence, its alveolar process being the part more commonly involved ; less frequently, the fracture takes place through the body of the jaw or one of the other processes, and it may also involve the *malar bone* and *zygomatic arch.*

The fracture, which is often compound and accompanied by bruising and swelling of the cheek, may or may not be attended by displacement of the fragments ; when the anterior wall of the antrum is driven in, considerable deformity is often produced, and when the alveolus is involved, there will be loosening and irregularity in the line of the teeth.

Various complications may attend this fracture ; *e.g.* emphysema ; severe hæmorrhage from a wound of the internal maxillary artery ; loss of sensation in the cheek from injury to the infra-orbital nerve ; in cases of compound fracture involving the antrum, a sinus often remains which is slow in healing.

Treatment.—When any displacement of the fragments is present, an attempt should be made to correct it as soon as possible ; the depressed bone can often be raised from the mouth, or, if this is not possible, by means of an elevator introduced through a small opening in the cheek.

When the alveolar process is involved, the fragments can usually be kept in position by one or other of the methods of treatment mentioned in the case of the lower jaw ; a jaw bandage should afterwards be applied so as to prevent, as far as possible, any movement of the part, and the patient fed on liquid food for several weeks.

Lower jaw.— Fractures of the lower jaw are almost always compound, sometimes from external wound, but more frequently from laceration of the gum by the broken fragments. Any part of the bone may be broken, the commonest situation being through

the body, at that spot where it is specially weakened by the mental foramen and the deep socket for the canine tooth ; fracture through the symphysis is rare owing to the strength of bone at this point.

Body.—In fracture through the body the symptoms are usually well marked, especially when, as is often the case, the bone is broken on both sides of the symphysis, for the central portion is then drawn down by the muscles attached to the hyoid bone. There is mobility of the fragments, with crepitus, loosening and irregularity in the line of the teeth, dribbling of the saliva from the mouth, and impairment of speech.

When the fracture is compound, there is also laceration of and bleeding from the gums ; under these circumstances suppuration generally results, and the discharge making its way into the mouth and mingling with the saliva gives to the breath an offensive odour ; in cases where an abscess forms at the seat of injury, necrosis of a portion of the jaw frequently results. The inferior dental nerve usually escapes, but if it happens to be torn across by the fracture, there will be loss of sensation in the lip on the corresponding side.

Angle or lower part of ramus.—In this situation the displacement of the fragments is usually slight, for the muscles on either side (masseter and internal pterygoid) maintain them in position.

Neck.—In fracture through the neck of the jaw, the condyle is drawn inwards and forwards by the external pterygoid ; crepitus is produced and pain is experienced upon attempting to open the mouth.

Coronoid process.—The fractured coronoid process is drawn upwards and backwards by the temporal muscle, so that it produces an undue prominence in the temporal fossa.

Treatment.—In cases where there is not much displacement of the fragments, they can often be kept in position by a four-tailed bandage, or by a guttapercha

splint (Fig. 2), moulded to the jaw, and fixed by a similar bandage. Any teeth which are completely loose and lie between the fragments should be removed, for their presence interferes with the process of repair; those which are only partially loose should, if healthy, be allowed to remain, for they will, as a rule, soon become firmly adherent. When difficulty is experienced in keeping the fragments in position, as often happens when the fracture is compound, other means may be required.

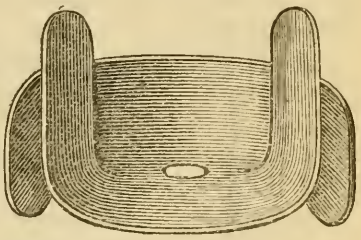

Fig. 2.—Guttapercha Splint for Jaw. (From Pick's "Fractures and Dislocations.")

Ligaturing the teeth, *i.e.* binding together those which lie on either side of the fracture, with wire or silk, is sometimes adopted, but has this disadvantage, that it tends to loosen the teeth, which are often already somewhat loose in their sockets. The ligature is also very liable to slip, and in many cases, *e.g.* when the teeth are absent or carious, it cannot be applied.

The fragments may be wired together, as recommended by Thomas, by means of sutures of silver wire, which are passed through openings drilled in the bone on each side of the fracture (Fig. 3), or through the bone on one side and between the teeth on the other; as the wire, if tied or fastened with a cross twist in the ordinary way, soon becomes loose, it is twisted with a key in three or four coils, which can be tightened up from time to time as they become slackened.

Various forms of interdental splints are also employed, *e.g.* moulds of guttapercha, vulcanite or metal caps, etc., which fit on to the teeth for some distance on either side of the fracture.

Moon's interdental splint consists of two parts, an external splint adapted to the and chin attached by rods to a metal cap, which fits the teeth of the fractured jaw.

Hammond's wire splint is made of a framework of iron wire, adjusted so as to encircle, on a level with their necks, all or several of the teeth on either side of the fracture.

As it is important that the fracture, should, as far

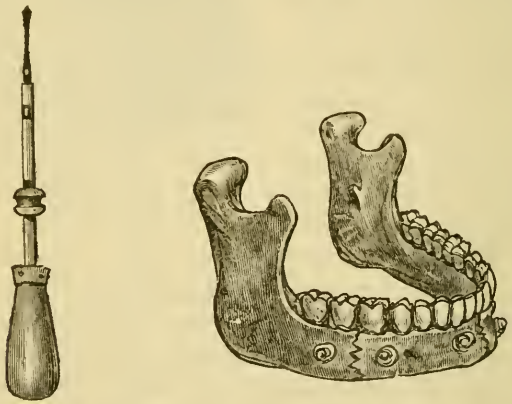

Fig. 3.—Thomas's Drill and Suture for Fractured Jaw.

as possible, be kept completely at rest, talking should be prohibited, and the patient fed on liquids, or on soft food which requires no mastication. The mouth should, especially in cases of compound fracture, be frequently washed out with a solution of Condy's fluid, or some other disinfectant.

Union, as a rule, takes place in from three to five weeks, though the process will be somewhat retarded if suppuration takes place, or if necrosis results.

THE CLAVICLE.

The clavicle may be fractured in any part of its course, more commonly about its middle, less frequently

at either its sternal or acromial extremity. Though fracture may be produced as the result of direct application of force, *e.g.* a severe blow, or even of muscular action, *e.g.* a sudden and forcible swing of the arm, it is far more frequently the result of indirect violence, *e.g.* a fall on to the shoulder or hand when the arm is extended.

Shaft.—In fracture through the shaft the bone usually gives way at its weakest point, viz. about its centre, or a little external to it, just at the junction of the two curves. The fracture, which is of very common occurrence in young subjects, is often of the incomplete or "greenstick" nature, the bone being bent, or only partially broken, the periosteum frequently remaining untorn (Fig. 1).

When complete, the line of fracture is sometimes transverse, but more commonly and especially when due to indirect violence, it is oblique; under these circumstances the amount of displacement is often considerable. The inner fragment usually remains unaffected, being retained in its place by the antagonistic action of the sterno-mastoid above, and the pectoralis major and subclavius muscles, and rhomboid ligament below; though, in many cases, it appears to be displaced forwards, this is in reality due to the depression of the inner end of the outer fragment backwards and behind it.

The outer fragment, owing to the weight of the arm, which drags upon it, is usually drawn downwards, while by the action of the muscles passing to it from the chest it is drawn somewhat inwards and forwards; hence, its outer or acromial end with the shoulder is displaced downwards, inwards, and forwards, while its inner or fractured end is drawn inwards and backwards, so that it lies behind and usually beneath the fractured end of the inner fragment; less frequently it is found above, and in rare cases it may lie anterior to it.

The *symptoms* are as follows: Flattening and lowering of the shoulder, which is also drawn forwards and inwards, being approximated to the middle line; pain at the seat of injury; impaired movement of the arm; inclination of the head and neck to the affected side; the elbow is often supported by the opposite hand to take off the weight of the limb; if the finger is laid over the seat of fracture, crepitus can generally be detected on raising and rotating the shoulder, and at the same time pain will be produced; the prominence formed by the fractured end of the inner fragment will generally be plainly perceptible beneath the skin; in cases of transverse fracture, where the displacement of the fragments is often very slight, there may be an entire absence of any deformity.

Sternal end.—Fracture of the sternal end of the clavicle, either internal or external to the attachment of the rhomboid ligament, is an injury of rare occurrence; in the latter case the displacement is often considerable, the outer fragment being drawn downwards and forwards; in the former case, which is much less common, there is not, as a rule, any marked displacement of the fragments.

Acromial end.—Fracture of the acromial end is of much more frequent occurrence, and two varieties are met with, according as the bone is broken between or external to the conoid and trapezoid ligaments. When the fracture is between the ligaments there is little, if any, displacement of the fragments; on rotating the shoulder crepitus is produced, and perhaps slight irregularity will be felt at the seat of injury.

When the fracture is external to the ligaments there is a marked displacement of the outer fragment, its articular surface being turned forwards and inwards, with a slight inclination downwards, so that it lies nearly at a right angle with the rest of the bone, the position of which is not materially altered.

Separation of the epiphysis of the clavicle, a thin plate of bone at its sternal extremity, is a rare injury.

Fractures of the clavicle, when the result of direct violence, may be compound or comminuted ; in these injuries, which are, however, of rare occurrence, the neighbouring large vessels, *e.g.* jugular or subclavian veins, etc., are liable to be wounded. A simple fracture is occasionally followed by partial paralysis of the arm, the result probably of compression or laceration of the cords of the brachial plexus by the displaced fragments. Owing to the difficulty of keeping the fracture in a state of complete rest, union is invariably attended by the formation of provisional callus, and in cases where treatment has been neglected, or there is much displacement of the fragments, this is often excessive in amount, giving rise to a considerable swelling surrounding the bone at the seat of injury.

Treatment.—In the treatment of the common form of fracture through the shaft there are three main indications to be carried out, viz. to raise the shoulder with the outer fragment, and at the same time to draw it backwards and outwards.

To raise the shoulder, the arm should be supported in a sling which reaches well under the elbow, or by strapping or bandages which pass beneath the elbow and over the opposite shoulder.

To draw the shoulder outwards, a thick, wedge-shaped pad, with its broad end upwards, should be placed high up in the axilla, where it is kept in position by a strap which passes over the opposite shoulder. The arm being then bandaged to the side, the pad acts as a fulcrum, and the humerus as a lever ; the result is that the shoulder and outer fragment are drawn forcibly outwards. In applying the pad, care must be taken that too much pressure is not made

upon the axillary vessels and nerves, or else the arm will become swollen, and either numb or painful.

To carry the shoulder backwards, several different plans may be adopted. The elbow may be carried forwards, and the hand raised towards the opposite shoulder, so that the humerus may bear across the pad, and its upper end along with the shoulder be forced backwards; or a figure of 8 bandage may be applied to the shoulders and tied behind.

In order to prevent the bandages from slipping, the turns may be stitched together, or stiffened with plaster of Paris or starch. If there is any tendency to swelling of the arm, it should first be bandaged from the fingers up to the axilla.

Sayre's method of treating this fracture is as follows: A loop at the end of a broad band of adhesive plaister is passed round the upper part of the arm, and the elbow having been drawn backwards, the strapping is carried transversely behind the back and round the chest. A second piece is then carried obliquely across the body, viz. over the sound shoulder, and beneath the elbow on the injured side, a slit being cut in it to receive the elbow and prevent it from slipping. By the first strip the shoulder is drawn backwards and outwards, while by the second it is raised (Fig. 4).

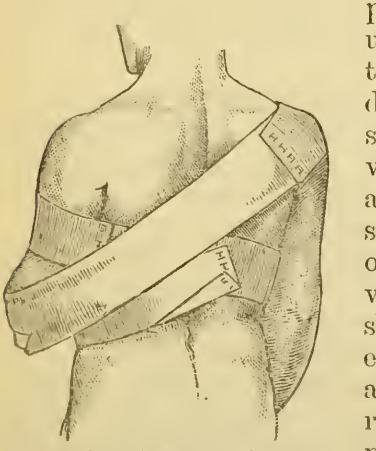

Fig. 4.—Sayre's Method for Fractured Clavicle.

Ellis's method consists in the application of an axillary splint or crutch, which is maintained in

position by two straps, one passing over the opposite shoulder, the other round the chest; the latter also fixes the upper arm and keeps it to the side; the fore-arm is supported in an ordinary sling (Fig. 5).

If a patient will submit to confinement to bed, it will generally be found that the deformity more or less completely disappears in the recumbent posture, for the weight of the limb being removed, the displacement downwards is prevented; at the same time, the shoulder falling back and carrying with it the outer fragment, the displacement forwards and inwards is also counteracted; the consequence is that the ends of the bone usually fall well into position. Mr. Bryant recommends that an attempt should be made to imitate what takes place when the patient is in the supine position, by placing a pad over the blade of the scapula below its spine, and then binding the bone firmly to the thorax by broad strips of strapping, which obliquely encircle the chest on the affected side and reach from the spine to the sternum. The arm should also be supported in a sling and the hand drawn upwards towards the opposite shoulder.

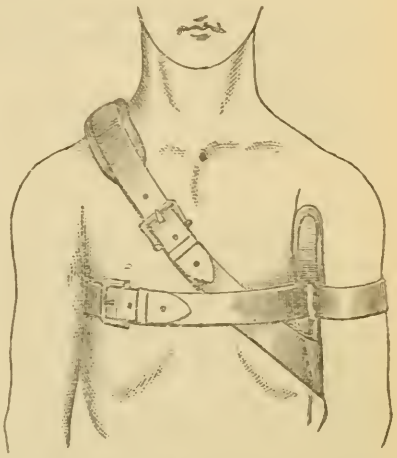

Fig. 5.—Ellis' Method for Fractured Clavicle. (From Pick's "Fractures and Dislocations.")

In cases where no displacement of the fragments is present, as may occasionally happen in fracture through the shaft, or in fracture internal to the

rhomboid, or between the conoid and trapezoid ligaments, all that is often necessary is to keep the arm fixed to the side and supported in a sling.

In fracture external to the conoid and trapezoid ligaments, in addition to a thick pad in the axilla, it will often be found necessary to apply a figure of 8 bandage behind the shoulders, in order to overcome the displacement forwards of the shoulder with the outer fragment.

Union is, as a rule, effected in from three to four weeks.

THE SCAPULA.

Fracture of the scapula may involve its body, neck, acromion, or coracoid process.

Body.—Fracture through the body is usually the result of direct violence and is often associated with injury to the subjacent ribs. It is not, however, an accident of very common occurrence, for the thick layers of muscles which lie both over and beneath the bone form, as it were, soft pads which serve to protect it. The fracture usually affects the infraspinous portion of the bone, running across it in an oblique or transverse direction; or it may extend in a vertical direction right through the spine.

Abnormal mobility and crepitus can generally be detected on moving the shoulder and upper part of the scapula with one hand, while the other is laid upon, or made to fix, the lower portion of the bone. In muscular subjects, and when the fracture involves the infraspinous fossa, there will often be slight, if any, displacement of the fragments; when, however, it runs across the spine, some irregularity in its course can usually be detected.

Acromion. — Owing to its exposed position, forming as it does the tip of the shoulder, the acromion is more frequently fractured than any other

portion of the bone, and usually as the result of direct violence.

Abnormal mobility and crepitus can be readily detected on raising and rotating the shoulder; more or less deformity is present, the shoulder becoming flattened and somewhat depressed. On running the finger along the acromion, an irregularity can be felt at the seat of fracture; pain is present and the movements of the arm are interfered with.

There are two affections which simulate fracture of the acromion, viz. non-union of the acromial epiphysis, a condition which sometimes exists, and certain cases of rheumatic arthritis of the shoulder joint, in which osteophytic deposits about the acromion are found lying loose and movable beneath the skin; under these circumstances, crepitation can usually be detected.

Coracoid process.—Fracture of this process is rare, lying as it does in a hollow protected by the clavicle above, the thorax internally, and the head of the humerus externally; it is usually the result of direct violence. The only symptoms present will be mobility of the broken fragment, with pain and crepitus on manipulation; if the coraco-clavicular ligament is ruptured, the fractured process may be drawn downwards by the action of the biceps and coraco-brachialis muscles.

Neck.—Fracture through the neck of the scapula is so rare that its occurrence has been doubted; two varieties have, however, been described according as the anatomical or surgical neck of the bone is involved.

In fracture through the **surgical neck** the line of fracture runs across the constricted portion of the bone opposite the notch in the superior costa, the coracoid process being included in the detached piece. If the coraco-clavicular and coraco-acromial ligaments are not ruptured, there may be very little deformity; if,

however, they give way, the broken fragment along with the arm is displaced downwards, so that the symptoms are very similar to those of subglenoid dislocation of the humerus ; viz. there is flattening and lowering of the shoulder, with prominence of the acromion and a depression beneath it; the arm is lengthened and somewhat separated from the side; the head of the humerus can be felt in the axilla.

The injury differs, however, from dislocation in the following points ; the coracoid process is displaced and moves with the arm, which is abnormally mobile ; crepitus can readily be detected ; on raising the arm, the deformity disappears, but at once returns when the arm is allowed to drop ; an irregular mass of bone, formed by the neck of the scapula, can be felt in the axilla, very different to the smooth, rounded prominence formed by the head of the humerus, which alone is present in cases of dislocation.

In fracture through the **anatomical neck** the glenoid process only is separated from the rest of the bone ; the symptoms will be very similar, except that the coracoid process preserves its normal relation and does not move with the arm.

Treatment.—In fracture through the body the fragments should be brought into position, and then maintained so by a pad of lint, secured by strips of strapping which encircle half the chest. The arm should be fixed to the side by a body bandage and the elbow supported in a sling.

In fracture through the acromion the elbow should be well supported by a sling, or by a broad strip of strapping (as in the case of the clavicle) which passes beneath it and over the opposite shoulder. A pad should be fixed in the axilla and the arm bandaged to the side.

In fracture through the neck a similar plan of treatment is required.

In fracture through the coracoid process the forearm should be flexed and carried across the chest, so that the hand rests on the opposite shoulder, in order to relax the biceps and coraco-brachialis muscles; the elbow should also be supported in a sling.

The Humerus.

Fractures of the humerus may be divided into fractures of the upper extremity, shaft, and lower extremity.

Upper extremity.—Fractures of the upper extremity may be subdivided into fractures of the anatomical and surgical neck, separation of the great tuberosity and of the upper epiphysis. They are usually produced by direct violence, *e.g.* a fall or blow upon the shoulder; less frequently they follow falls upon the hand or elbow.

Anatomical neck.—Fracture through the anatomical neck, *i.e.* above the tuberosities and within the capsule of the joint, is not of common occurrence; it may be either impacted or non-impacted.

In the *impacted* form the small upper fragment is usually driven into the wide surface of cancellous tissue at the upper end of the lower one.

The symptoms are as follows: the axis of the humerus is altered, being directed somewhat inwards towards the coracoid process, and the elbow being slightly separated from the side; the arm is shortened and the shoulder somewhat flattened; the acromion is more prominent than usual, and there is a slight depression beneath it; the head of the humerus can be felt in the glenoid cavity, and in many instances some alteration in its shape can be detected; crepitus is absent, unless the impaction is forcibly broken down. There is loss of power, with pain, stiffness, and swelling about the shoulder.

In the *non-impacted* form less deformity is

generally present; a slight projection can be felt on the inner aspect of the joint, caused by the upper end of the lower fragment; crepitus can be detected on rotating the arm, which is slightly shortened. It might be expected that the head of the bone, being severed from all its connections, and thereby deprived of its vascular supply, would necrose, but this result very rarely takes place, fibrous or even osseous union being usually effected. This is probably owing to the fact that its separation is often not complete, its vitality being maintained through the medium of portions of the capsule which remain attached to it. When osseous union takes place the callus is mainly thrown out by the lower fragment. When the union is merely fibrous, considerable atrophy of the head of the bone is often produced.

Treatment.—In impacted fracture all that is required is to keep the part at rest, by bandaging the arm to the side and supporting the elbow in a sling. Care should be taken not to break down the impaction by the employment of any force. If the soft parts about the shoulder are bruised and swollen, some evaporating lotion should be applied.

In non-impacted fracture it is, in addition, sometimes necessary to fix a small pad in the axilla, and fit a guttapercha or felt cap to the shoulder, so as to keep the parts in apposition and completely at rest.

Surgical neck.—Fracture through the surgical neck is the variety most commonly met with about the upper end of the humerus, the bone being usually broken below the tuberosities and above the insertion of the pectoralis major and latissimus dorsi; the fracture may be either impacted or non-impacted.

In the *non-impacted*, the more common variety, there is considerable displacement of the fragments.

The upper fragment is rotated outwards, and slightly elevated under the coraco-acromial ligament

by the muscles inserted into the two tuberosities. The lower fragment is drawn forwards, upwards, and inwards beneath the coracoid process, by the muscles passing from the trunk to the arm, and by the flexors of the arm; at the same time the lower end of the shaft is thrown obliquely outwards from the side by the action of the deltoid.

The *symptoms* are as follows: the lower fragment forms a distinct prominence beneath the coracoid process, most marked when the elbow is raised; the head of the bone can be felt in the glenoid cavity; consequently there is no hollow immediately below the acromion, though a slight depression is often present a little lower down, viz. just below the end of the upper fragment; the axis of the limb is altered, being directed upwards and inwards towards the coracoid process; crepitus can be detected on extending and rotating the limb; the arm is shortened and abnormally mobile; owing to irritation of the branches of the brachial plexus by the lower fragment, pain is often present, shooting down the arm.

In the *impacted* form the lower fragment is usually driven into the upper. The symptoms are chiefly of a negative character, the usual signs of fracture being absent; slight shortening is present, with impaired movement, deformity, and alteration in the axis of the limb; crepitus is absent unless the impaction is broken down. The circumflex nerve, owing to its close relationship to the neck of the humerus, is liable to be wounded at the time of fracture, or it may afterwards become included in the callus by which repair is effected; under these circumstances, paralysis of the deltoid, followed by atrophy, is liable to occur.

Treatment.—In impacted fracture the treatment is the same as in the case of the anatomical neck.

In non-impacted fracture there is the triple

displacement of the lower fragment to be remedied; the displacement inwards may be counteracted by placing a thick pad in the axilla and bandaging the elbow to the side; the displacement forwards by bandaging the elbow to the side of the chest in front of the lateral median line, so as to throw backward the upper end of the shaft; the displacement upwards by supporting the hand only (not the elbow) in a sling, so that the weight of the arm may act on the lower fragment and drag it down (Fig. 6). To ensure the part being kept completely at rest, a gutta-percha or felt cap may in addition be fitted to the shoulder, and if there is any tendency to swelling of the limb, it should be bandaged upwards from the fingers.

Fig. 6.—Treatment of Fracture of the Surgical Neck.

In fractures of the neck of the humerus, union takes place in four to five weeks, when passive movement should be begun; in the impacted forms the patient should be warned of the stiffness and deformity which will be permanent.

Separation of the great tuberosity.—This injury may occur alone, but more commonly in connection with a dislocation forwards of the humerus; under these circumstances the detached portion of bone is drawn backwards by the muscles inserted into it, so that it lies under or external to the acromion process, while the head of the humerus is drawn forwards beneath the coracoid process.

The symptoms are usually well marked; there is an increase in the breadth of the shoulder; a projection formed by the detached tuberosity can be felt at the outer and back part of the joint, while between this and the head of the bone, which lies beneath the coracoid process, a distinct gap or vertical sulcus is evident; crepitus is absent unless the fragments are brought into apposition with one another.

Treatment.—An attempt should be made to bring the fragments into contact, and then to maintain them so by pads of lint and strapping, a cap being also moulded to the shoulder. An axillary pad will often be found useful, and the arm should also be supported in a sling and bandaged to the side.

Separation of upper epiphysis.—Separation of the upper epiphysis of the humerus, which includes the head and both tuberosities, is often met with in young subjects; occurring, as it does, just above the usual situation of fracture through the surgical neck, the symptoms of the two injuries are very similar. In separation of the epiphysis, however, the lower fragment is smooth and rounded instead of being sharp and irregular as in fracture; crepitus is absent or much less distinct, owing to the fact that the line of separation runs through cartilage and not through bone.

The *treatment* is the same as in fracture through the surgical neck.

Shaft.—Fracture through the shaft of the humerus is often met with as the result either of direct or indirect force; it usually occurs about the middle of the bone.

If the fracture is above the insertion of the deltoid, the upper fragment is drawn inwards by the pectoralis major, latissimus dorsi, and teres major; the lower fragment is drawn upwards by the coracobrachialis and biceps, and outwards by the deltoid;

consequently, shortening is present along with deformity, the lower fragment projecting above, behind, and to the outer side of the upper one.

If the fracture be below the insertion of the deltoid, the displacement is often very slight when the line of fracture is transverse; when, however, it is oblique, the lower fragment is drawn upwards by the biceps and triceps so as to overlap the upper one. The musculo-spiral nerve, owing to its close relationship with the middle of the shaft of the humerus, is liable to be wounded at the time of fracture, or it may subsequently become included in the callus; under these circumstances, if paralysis of the nerve accompanies or follows the injury, the patient will present evidences of "wrist-drop," with loss of power of extension and supination in the fore-arm.

Non-union is more frequently met with as a complication of fracture through the shaft of the humerus, than in the case of any other long bone. Various theories have been advanced to account for the fact, viz.: (1) Interposition between the fragments of the muscular tissue which surrounds, and is directly adherent to, the shaft of the bone. (2) Non-apposition of the fragments from imperfect support to the arm. (3) Injury to the nutrient artery of the bone. (4) Imperfect fixation of the shoulder joint. (5) The tendency to movement at the end of fracture, when, the elbow joint being fixed in splints, the fore-arm is flexed or extended.

Treatment.—A rectangular splint reaching from the axilla to the fingers should be applied to the inner side of the limb, care being taken that it is well padded where it presses over the inner condyle and also at its upper end, which must not reach too high in the armpit; three short splints, reaching from the shoulder to the elbow, should also be applied to the anterior, posterior, and the outer aspects of the upper

arm. In most cases the hand and wrist only should be supported in a sling, the elbow and fore-arm being allowed to hang, so that the weight of the latter, by dragging on the lower part of the shaft, may counteract the tendency to overlapping of the fragments, which usually exists.

Stromeyer's cushion, a triangular wedge-shaped pad, is often useful in cases of compound fracture; it is interposed between the chest wall and arm in such a way as to form a support for the limb, the elbow resting upon its thick end.

Union, as a rule, takes place in five or six weeks.

Lower extremity.—Four different forms of fracture are met with about the lower end of the humerus, viz. transverse supracondyloid, T-shaped, separation of either condyle and of the lower epiphysis.

Transverse supracondyloid.—In this variety the shaft is broken across, just above the condyles; the line of fracture, though transverse, is generally somewhat oblique from above downwards and forwards, so that the lower fragment is drawn upwards behind the upper one by the biceps, brachialis anticus, and triceps. The symptoms are very characteristic; there is an irregular projection in front of the joint above the bend of the elbow formed by the upper fragment, which pushes forwards the brachial artery, and another behind, formed by the lower fragment and bones of the fore-arm. Crepitus and abnormal mobility are present, along with pain and swelling about the joint. The deformity can be easily reduced, but at once re-appears when extension is left off. The distance between either condyle and the olecranon will be normal, while between either condyle and the acromion it will be diminished.

If the line of fracture runs in the opposite direction the position will be reversed, the lower fragment being drawn upwards in front of the upper one.

This fracture is liable to be mistaken for dislocation of the radius and ulna backwards; for in both injuries, which are common in young subjects, there is a prominence in front of the elbow and another behind, with loss of power, and pain and swelling about the joint. The diagnosis of fracture can, however, be made by attention to the following points: the presence of crepitus and increased mobility about the lower end of the humerus; the fact that the anterior projection, which is formed by the upper fragment, is rough and irregular, and above the bend of the elbow, not below as in dislocation, where, being formed by the articular end of the humerus itself, it is broad, smooth, and rounded; the fact that there is no increase in the distance between either condyle and the olecranon, while shortening is present on measuring from the acromion to either condyle; the fact that the deformity is readily reducible, but at once returns when extension is discontinued, will usually serve to distinguish fracture from dislocation.

T-shaped fracture into the joint.—In this variety there is, in addition to a transverse fracture above the condyles, a vertical crack or fissure running between them and involving the elbow joint.

Swelling about the joint, owing to effusion into its interior, is always a prominent symptom, often rendering the diagnosis of the injury somewhat difficult; the lower end of the humerus will probably appear to be somewhat increased in width, and crepitus can, as a rule, be readily detected on flexing and extending the fore-arm, or on grasping the two condyles and moving them upon each other.

Separation of either condyle.—Either condyle of the humerus may become separated by a simple crack or fissure, running obliquely across the lower end of the bone. In separation of the outer, or the whole of the inner condyle, the elbow joint is necessarily

opened. In the case of the inner condyle, its tip, which is more prominent and consequently more liable to fracture, is often separated ("epicondylar fracture") without the joint being involved. There is not, as a rule, much displacement of the fractured condyle, though at times it is drawn down by the muscles attached to it, so that the characteristic projection on either side of the joint is lost. The elbow becomes painful and swollen, its movements are impaired, and crepitus can readily be detected.

In fracture of the external condyle the musculo-spiral nerve or its subdivisions (more especially the posterior interosseous), and in fracture of the internal condyle the ulnar nerve, may become wounded at the time of injury, or afterwards included in the callus by which repair is effected. Under these circumstances symptoms of paralysis of these nerves will accompany or follow the fracture.

Separation of lower epiphysis.—Separation of the lower epiphysis of the humerus, viz. of the two condyles with the trochlea and capitellum, is often met with in young subjects, as the result of a fall upon the elbow. Occurring almost in the same situation as the transverse supracondyloid fracture, the symptoms are very similar to those met with in that injury. In separation of the epiphysis, however, the fragments are more smooth and rounded than in fracture, and for this reason, crepitus is less distinct or altogether absent. The line of separation is also just above the joint, nearer to it than is often the case in fracture.

In rare cases the trochlea and capitellum only are separated, the condyles being left attached to the shaft of the bone, the so-called "infracondyloid separation of epiphysis."

Treatment.—Most cases of fracture of the lower end of the humerus may be treated with an internal rectangular splint, reaching well up the arm and down

to the fingers; the elbow should be kept at a right angle, and the fore-arm, in a position midway between pronation and supination, should be supported in a sling. Some cooling lotion should be applied to the joint when evidences of synovitis are present.

In separation of the lower epiphysis and in transverse supracondyloid fracture, when the fragments cannot be kept in position by this treatment, it is sometimes recommended to apply an angular splint, fitting the bend of the elbow, to the front of the limb, and a straight splint to the back of the upper arm, so as to push the upper fragment backward, and the elbow with the lower one forward; or the position of the splints may be reversed, the angular one being applied behind, and the straight one, reaching to the bend of the elbow, in front; care should, however, always be taken that too much pressure is not employed, otherwise there is a risk of the supervention of gangrene from compression of the brachial artery between the shaft of the humerus and the anterior splint.

At the end of two or three weeks passive movement should be cautiously commenced, the splints being removed and re-applied daily. When the joint is involved, it is sometimes advisable, especially with children, to commence at an earlier period, *e.g.* as soon as ten days after the accident. In most cases, however, more or less stiffness will remain for a time, and where the elbow joint is implicated, the patient should be prepared for the impairment in its movements, which is often permanent.

Firm union will, as a rule, take place in from four to six weeks.

In cases of compound fracture involving the elbow joint, an attempt should be made to save the limb, unless the soft tissues are extensively lacerated and there is much splintering of bone; any loose fragments

should be removed, and occasionally a primary excision of the joint, either partial or complete, may be required. A plaster of Paris splint, interrupted at the elbow with pieces of strong wire, iron hoop, etc., will be found a useful apparatus in these cases, as it allows access to the wound for dressing, and at the same time keeps the part in a state of perfect rest.

THE FORE-ARM.

Fractures of one or both of the bones of the fore-arm are of very frequent occurrence.

Radius and ulna.—Fracture of both radius and ulna is often met with, generally as the result of direct violence, a fall upon the hand being more commonly followed by fracture of the radius alone than of both bones. The usual situation is through their middle or lower third, their upper third being better protected by the thick covering of muscles. The line of fracture is usually transverse, both bones are broken on the same level, or nearly so. The upper fragments are drawn forwards by the action of the biceps, pronator teres, and brachialis anticus, the radius being somewhat approximated to the ulna. The lower fragments are drawn together by the pronator quadratus, and upwards, either in front of or behind the upper fragments, by the flexor and extensor muscles.

There is more or less shortening of the fore-arm, with, in many cases, considerable deformity, the lower fragments, which usually overlap the upper, forming a projection on either the anterior or posterior surface of the limb; crepitus can be readily detected, and abnormal mobility is also present.

Treatment.—The fore-arm should be bent to a right angle and placed in a position midway between pronation and supination, *i.e.* with the thumb pointing upwards. Two straight splints, reaching from the

elbow to the fingers, should be applied to the anterior and posterior surfaces of the limb. In this position the radius and ulna will be parallel with one another, and the interosseous space will consequently be preserved. The splints should be slightly broader than the limb, so that the bandages may not press upon the arm and force the bones together. In some cases it may be necessary to apply a narrow pad along the interosseous space, in order to keep the radius and ulna apart; otherwise they might become united together by callus thrown out across the space, a result which would afterwards interfere with the movements of pronation and supination.

Union is generally effected in from three to four weeks.

Radius.—Fracture of the radius alone may take place through its neck, shaft, or lower end, the latter situation being the most common.

Neck.—Fracture through the neck of the radius is an uncommon injury, and one that is often difficult to detect, owing to the fact that very little displacement of the fragments is usually present, the bone at this spot being surrounded by a layer of muscle. The movements of the fore-arm, especially supination and pronation, are interfered with; on placing the finger over the fracture and rotating the hand, crepitus can be detected, and unless the fragments are interlocked, the head of the radius will not rotate with the shaft of the bone.

The *treatment* is the same as in fracture through the shaft.

Shaft.—Fracture through the shaft of the radius is more common than fracture of the ulna alone, for, being situated on the outer aspect of the limb, it is more exposed to direct violence; moreover, its shaft is not so strong as that of the ulna, and it also has a more direct connection with the wrist. It may be

due to direct violence or to a fall upon the hand. The usual seat of fracture is about its middle; if above the insertion of the pronator teres, the upper fragment is flexed by the biceps and fully supinated by the supinator brevis; if below, the upper fragment will be in a position midway between pronation and supination, the action of the supinator brevis being more or less counteracted by that of the pronator teres. The lower fragment is pronated and drawn towards the ulna by the pronator quadratus. The symptoms are usually well marked: a prominence is formed on the front of the upper part of the fore-arm by the upper fragment, and there is a depression at the seat of fracture, both fragments being drawn inwards towards the ulna. Crepitus is produced on pressing the fragments together, or on rotating the hand, and there is loss of power of pronation and supination, with abnormal mobility.

The *treatment* is the same as in fracture of both bones of the fore-arm. When, however, the radius is broken high up, it is sometimes necessary to keep the fore-arm well supinated by means of an angular splint applied to the back of the upper arm and fore-arm, for, the upper fragment being fully supinated, the proper axis of the limb will not be maintained if the lower one is kept in a position midway between pronation and supination, as in the ordinary method.

Lower extremity.—Fracture of the lower end of the radius is very common, one variety being known as **"Colles' fracture,"** after the celebrated Dublin surgeon, who was the first to accurately describe it. It is generally the result of a fall upon the palm of the hand when the arm is extended, and though met with at all ages and in both sexes, is more common after middle life, and especially in females.

The seat of fracture is usually half an inch to one and a half inches above its lower end, just at the

weakest portion of the radius, *i.e.* where the shaft begins to expand into the broad articular extremity, which is mainly composed of cancellous tissue, covered with a layer of compact bone much thinner than that of the shaft itself. The line of fracture is generally transverse, but may be oblique from side to side, or from before backwards; in some cases there is comminution of the lower fragment, and not unfrequently the fracture is impacted, the compact tissue of the shaft being driven into the cancellous tissue of the lower fragment by the same force that causes the injury.* The amount of displacement varies; in some cases scarcely any is present; more commonly it is considerable, and in Colles' fracture a very characteristic deformity is usually produced, viz.:

The lower fragment, carrying with it the hand, is driven upwards and backwards behind the upper one by the direction of the force and the combined action of the supinator longus, extensors of the thumb, and radial extensors, so that a prominence is formed on the back of the wrist, with a depression above it.

The upper fragment projects forwards, often lacerating the pronator quadratus, and is drawn by this muscle towards the ulna, forming a prominence on the front of the fore-arm just above the wrist from the flexor tendons being thrust forwards. There is some difference of opinion as to whether the fracture is generally impacted or not; when the deformity is permanent, and cannot be made to disappear, impaction is probably present; when, on the other hand, the fracture is readily reducible, impaction is absent.

* Mr. Clement Lucas has recently shown that in Colles' fracture, in addition to fracture of the radius, "there is usually either a fracture of the styloid process of the ulna, or a tear of the internal lateral ligament of the wrist joint, and, in addition, frequently a rupture of the triangular fibro-cartilage," the latter becoming detached from the edge of the radius (Guy's Hospital Reports, vol. xlii.).

The *symptoms* are as follows: pain and swelling about the wrist, with impaired movement, especially of pronation and supination. On viewing the limb sideways, its posterior surface presents a distinct prominence (formed by the lower fragment) just above the wrist; a little higher up a marked depression will be seen. Its anterior surface presents a depression above the wrist, corresponding in position with the dorsal projection, and most marked on its radial margin; while higher up, and corresponding with the dorsal depression, a distinct prominence is seen, formed by the projection forwards of the upper fragment.

On viewing the back of the limb it will be seen that the hand is drawn over to the radial side, so that its ulnar border is somewhat convex; the styloid process of the ulna (or, when this is fractured, the lower end of the ulna itself) is unusually prominent; the radial border of the wrist is slightly concave. When the styloid process of the ulna is not fractured, the tips of the two styloids will often be found on the same level.

When the fragments are not impacted, crepitus can, as a rule, be readily detected, the deformity can be made to disappear, and the bones brought into good position. If, however, impaction is present, crepitus is absent, and the deformity is permanent, unless the fragments are forcibly loosened from one another.

Treatment.—An attempt should be made to reduce the fracture, and when impaction is absent, or not very firm, this can usually be effected, the deformity then disappearing more or less completely. If, however, the ends of the bone are so fixed that they cannot be disengaged by the employment of moderate force, union will take place between the impacted fragments, and the wrist will, in consequence, remain stiff and deformed.

In the treatment of this fracture many different forms of apparatus are employed.

Two straight splints may be used, a palmar one reaching from the elbow to the lower end of the upper fragment, and a dorsal from the same point to the ends of the fingers. A thick pad should be placed over the end of the upper fragment, and another over the lower fragment, so as to press them into position. At the end of a week a shorter dorsal splint should be substituted, viz. one reaching only to the knuckles, so as to leave the fingers free.

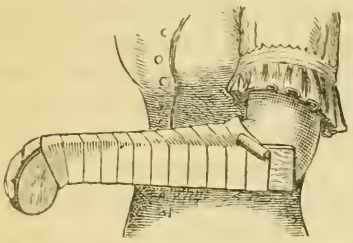

Fig. 7.—Nélaton's Splint for Colles' Fracture.

Nélaton's pistol splint (Fig. 7) is curved at one end like the handle of a pistol, so as to draw the hand over to the ulnar side; it is usually applied to the back of the fore-arm and hand (less frequently to the front) in conjunction with a short straight splint, reaching from the elbow to the lower end of the upper fragment, applied to the front of the arm. The pistol splint should be thickly padded where it presses on the lower fragment, and the palmar one where it presses on the radial border of the fore-arm and lower end of the upper fragment.

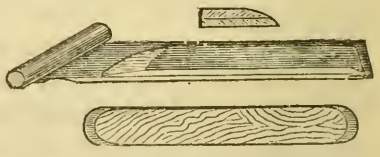

Fig. 8.—Carr's Splints for Colles' Fracture.

Carr's splint (Fig. 8) is applied to the palmar surface of the hand and arm in the prone position, the fingers grasping the cross bar which lies beneath the metacarpo-phalangeal joints; a short straight

splint is also applied to the dorsal surface of the fore-arm.

Whatever treatment is adopted, care should be taken that the fingers are left free, and the patient made to exercise them after the first week. The splints may generally be removed at the end of three or four weeks, and gentle passive movement of the wrist joint should then be commenced, otherwise more or less stiffness of the part will remain. In many cases, however, and especially in old people, in spite of the most careful treatment, the wrist joint will never quite recover its normal shape or movement.

Ulna. — Fracture of the ulna alone may occur through the olecranon, shaft, or styloid process, and in rare cases through the coronoid process.

Olecranon.—Fracture of the olecranon is not uncommon as the result of direct violence, *e.g.* falls, or blows on the back of the elbow; more rarely it is due to sudden and violent contraction of the triceps muscle.

More or less deformity is generally present, the broken fragment being drawn upwards by the action of the triceps. The nearer the fracture is to the tip of the process, the greater is the displacement, often to the extent of an inch or more. When the fracture is near its base, very little separation is often present, the fractured process being then retained in position by the periosteum and fibrous tissue which invest it.

When separation of the fragments is present, the prominence of the elbow is replaced by a depression, which is increased when the fore-arm is bent. Swelling rapidly ensues from effusion into the joint. The power of extending the fore-arm is lost. Crepitus is absent, unless the fractured process is drawn down into contact with the surface of the ulna. When no separation of the fragments has occurred, the depression at the back of the elbow will not be present; there will only

be slight loss of power in the arm, and crepitus can readily be obtained.

Union is usually effected by fibrous tissue, which may afterwards yield and allow of considerable separation of the fragments; the result is that the arm is often left considerably weakened, the power of extending the fore-arm being more or less impaired.

Treatment.—A straight splint should be applied to the front of the limb, more thickly padded where it fits the bend of the elbow, so that the joint may be very slightly bent; it will generally be found that the fragments come into more accurate contact in this position than if the arm is kept perfectly straight.

When separation of the fragments is present, the upper one should be drawn down by strapping, and a figure of 8 bandage, as in the case of the patella. As the fracture usually involves the joint, and is followed by effusion into its interior, it will often be necessary to subdue the swelling by some evaporating lotion before the fracture can be put up. Union generally takes place in four to six weeks, and at the end of this period passive movement should be commenced, otherwise ankylosis of the joint may take place.

In cases where separation of the fragments subsequently occurs from yielding of the fibrous tissue by which union is effected, a similar plan of treatment to that described in the case of the patella (page 83) may be adopted, viz. opening the joint and wiring the fragments; a few cases of recent fracture have also been treated in the same way.

Coronoid process.—Fracture of the coronoid process is extremely rare, except as a complication of dislocation backwards of the ulna. The broken fragment may be drawn upwards by the brachialis anticus.

Treatment.—The limb should be put up in splints at a right, or even at an acute, angle, in order to relax the muscle which tends to displace the separated process.

Shaft.—Fracture of the shaft of the ulna usually occurs through its lower third, this being the weakest part of the bone; it is most commonly the result of direct violence. The lower fragment is drawn towards the radius by the pronator quadratus, the upper fragment retaining its normal position, or being slightly displaced forwards by the brachialis anticus. A slight irregularity is present in the course of the bone at the seat of fracture, crepitus can be detected, and the movements of the fore-arm are impaired.

The *treatment* is the same as in fracture of both bones of the fore-arm.

Styloid process.—Fracture of the styloid process sometimes takes place, often occurring in cases of Colles' fracture.

The Hand.

Carpus.—Fractures of the carpal bones are of rare occurrence; when present, they are usually due to direct violence, *e.g.* a severe crush or blow. Owing to their numerous ligamentous connections, very little displacement takes place, though crepitus is generally a prominent symptom.

Treatment.—The fore-arm and hand should be supported on an anterior splint, and some cooling lotion applied over the wrist to subdue the inflammation of the neighbouring joints which is usually present.

Metacarpus.—Fractures of the metacarpal bones are not uncommon as the result of direct violence, the most common situation being through their middle or distal third. The displacement of the fragments is in some cases very slight, while in others it is considerable, the head of the bone dropping or sinking forwards towards the palm, and the fractured ends being displaced backwards so as to form an angular projection on the back of the hand.

Treatment.—In many cases an anterior splint with

a palmar pad is all that is required. When there is much displacement of the fragments, a palmar pad pressing upon the head of the bone, and another one over the dorsal projection with anterior and posterior splints, will often be found useful. Bending the fingers over a ball or thick pad, and then bandaging them in this position, is another plan of treatment sometimes adopted. Union generally takes place in three or four weeks.

Phalanges.—Fractures of the phalanges can readily be recognised by the presence of crepitus, abnormal mobility, and displacement of the fragments.

Treatment.—A narrow splint should be applied to the anterior surface of the finger.

THE PELVIS.

Fracture of the bones of the pelvis is usually the result of severe direct violence, and when complicated, as is often the case, with injury to the bladder, urethra, and other contents of the pelvis, is always of a serious nature.

1. **Through crest of ilium.**—Fractures separating only a portion of the crest of the ilium are not generally attended by much danger. The nature of the injury is usually evident, for, in addition to more or less pain and bruising about the seat of fracture, there will be mobility of the broken fragment, with crepitus on manipulation.

2. **Through pelvic basin.**—Fractures involving the pelvic basin are much more serious, owing to the fact that the viscera contained in it are so liable to injury. In many cases the fracture is multiple; *e.g.* it may involve both rami of the pubes, and sometimes, in addition, both rami of the ischium, so that the central portion of the pelvis is entirely separated; or it may involve the rami of the pubes and ischium in front,

and the ilium behind, close to the sacro-iliac synchondrosis, so as to separate one half of the pelvis.

The symptoms of the injury are usually manifest, for in addition to the bruising of the soft parts, there is severe pain, especially upon any attempt at movement, with inability to stand or sit erect: a line of ecchymosis is often present, extending along Poupart's ligament and the crest of the ilium, with discoloration of the skin over the sacrum and in the perinæum: crepitus and abnormal mobility can often be detected on grasping the iliac spines or crests and attempting to rotate or move them on each other; in some cases the displacement of the fragments will be evident, especially on examination by the rectum or vagina.

When the bladder or urethra is injured there will also be evidence of these complications.

3. **Through acetabulum.**—Fracture may take place through the rim or floor of the acetabulum owing to the head of the femur being driven violently against it.

(*a*) *Through floor.*—Fracture through the floor may occur as a simple crack or fissure, or there may be extensive splintering of the pelvic bones. In the former case there may be no very evident symptoms, with the exception of pain, especially on attempts to move the limb or stand erect, or upon pressure on the pubes; at first there is not any alteration in the length of the limb, but after a time slight shortening may ensue, probably owing to changes taking place in the cartilage of the head of the femur and acetabulum, and leading to absorption of the articular surfaces of the bones. In the latter case, crepitus can be readily detected on any movement of the limb, and if the head of the femur is driven into the pelvic cavity, there will be shortening of the leg with inability to move it, deformity of the hip, and probably evidences of injury to the contents of the pelvis.

(*b*) *Through rim.*—In fracture through the rim of the acetabulum, it is usually its upper and posterior part that gives way; consequently the head of the femur is liable to slip out of its socket, and the injury is, therefore, frequently accompanied by a dislocation of the thigh on to the dorsum ilii. When this is the case, the symptoms are usually obvious; in addition to those characteristic of dislocation, there will be distinct crepitus, and it will be found that the dislocation can easily be reduced, but will at once return when extension is discontinued.

4. **Through sacrum.**—Fracture through the sacrum is of rare occurrence except as the result of gun-shot injury; when due to other causes, *e.g.* severe crushes, etc., it is usually associated with fracture of the other pelvic bones, evidences of which will be present.

5. **Through coccyx.**—Fracture through the coccyx, or dislocation of this bone from the sacrum, is sometimes met with as the result of direct violence, or occurring during the straining efforts of parturition. The symptoms are pain at the part, increased on sitting, walking, and during the act of defæcation; crepitus and abnormal mobility will sometimes be present, and on introducing the finger into the rectum a slight projection will probably be felt on its posterior wall. In some cases this injury is followed by persistent pain ("coccydynia") in the region of the coccyx.

Treatment.—The patient should be kept in the recumbent position, and a broad bandage, padded belt, felt or guttapercha splint moulded to the part, applied to the pelvis so as to keep the parts completely at rest; in many cases it will also be advisable to tie the knees together.

In fracture of the acetabulum, extension should be employed by means of an outside splint, as in fracture

of the thigh; this is especially necessary when its rim is involved, in order to prevent the head of the femur from becoming displaced. Any complication which may be present, *e.g.* rupture of bladder or urethra, must be treated on ordinary principles.

In favourable cases, repair will be effected in from six to eight weeks.

The Femur.

Fractures of the femur may be divided into fractures of the neck, great trochanter, shaft, and lower extremity.

1. **Neck.**—Fractures of the neck of the femur may be subdivided into two great classes, viz. intracapsular and extracapsular, according as the bone is broken within or without the line of insertion of the capsular ligament. In many instances, however, the line of fracture lies partly within and partly without the insertion of the capsule. In either case the fracture may be impacted or non-impacted.

Intracapsular fracture is an injury of advanced life, being rarely met with in persons under fifty years of age; it is especially common in the female sex, and is usually the result of slight indirect violence, *e.g.* catching the foot and tripping up, missing a step in going downstairs, etc.; consequently it is not, as a rule, attended by any bruising or apparent injury to the soft parts about the hip. Its frequent occurrence in old people is no doubt owing to the alterations in structure and shape which take place in the neck of the bone as age advances. Not only is its nutrition impaired, as shown by the fatty degeneration of the cancellous and the thinning of the compact tissue, but the neck of the bone itself also becomes more horizontal, being set almost at a right angle to the shaft; consequently, becoming weakened from both these causes, it is liable to snap and give way as the

result of the application of a very slight degree of violence.

The fracture may be either impacted or non-impacted, the latter being by far the most common.

In the **non-impacted** variety the amount of displacement of the fragments varies; in most cases the lower fragment is drawn upwards, above and to the outer side of the upper one, and at the same time rotated outwards, so that its fractured surface looks more or less directly forward, while the upper fragment, being unacted upon by any muscles, retains its normal position. In cases where the periosteum and reflection of capsule, which invest the neck of the bone, are not torn through at the time of the injury, the separation of the fragments may at first be very slight.

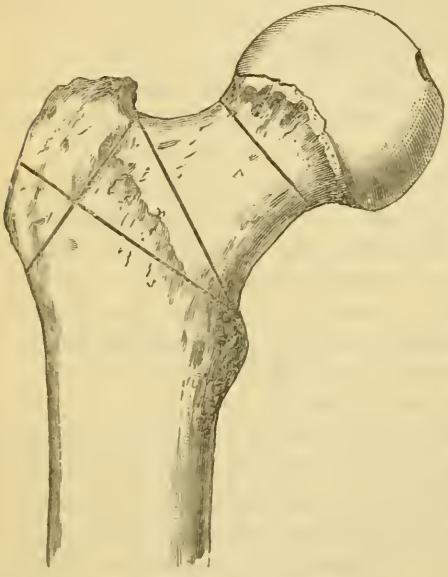

Fig. 9.—The most common Fractures of the Upper End of the Femur. (From Pick's "Fractures and Dislocations.")

The **symptoms** are as follows:

Alteration in the shape of the hip, which is somewhat flattened. Alteration in the position of the trochanter major, which is less prominent than usual, and approximated to the anterior superior iliac spine and also to the median line of the body. On rotating the limb it will also be found that the trochanter moves

through a smaller segment of a circle than on the sound side.

To verify the altered position of the trochanter major, the following tests may be employed.

(*a*) *Nélaton's line.*—In fracture of the neck, as in a dorsal dislocation of the femur, the upper border of the trochanter will lie above a line drawn from the anterior superior iliac spine to the tuber ischii.

In the normal condition, the upper border of the trochanter should just touch this line.

(*b*) *Bryant's ilio-femoral triangle.*—This (A B C, Fig. 10) consists of three lines; viz. A B, drawn from

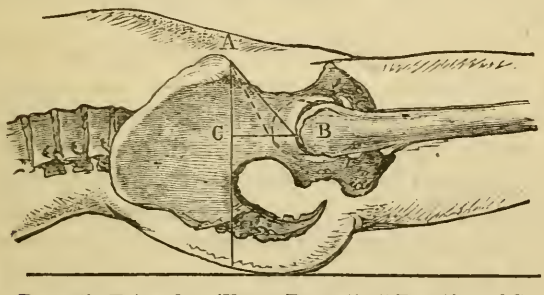

Fig. 10.—Bryant's Triangle. (From Bryant's "Practice of Surgery.")

the anterior superior iliac spine to the upper border of the trochanter major, corresponding in the normal state to the upper part of Nélaton's line; A C, drawn from the iliac spine at right angles to the horizontal plane of the recumbent body; C B, drawn at right angles from A C to A B, where it touches the top of the trochanter. The line C B, the base of the triangle, is the test line for fracture of the neck; in the normal condition it will, in an adult, measure about two and a half inches; in cases of fracture, when the trochanter is drawn up (represented by the dotted line in Fig. 10), it will become shortened, and measure about an inch less on the injured than on the sound side of the body.

(c) *Morris's bi-trochanteric or transverse measurement* "consists in measuring the distance from the median line of the body to the antero-posterior line at right angles to the long axis of the body, through the top of the trochanter on each side. The distance is always less on the side of the fracture."

3. Crepitus, sometimes indistinct, but usually perceptible on drawing down the limb and rotating it inwards, so as to bring the fragments in apposition.

4. Pain on pressure and especially on the movement of rotation.

5. More or less swelling about the joint especially in the groin, but usually without any evidence of bruising.

6. Shortening of the limb, varying from half to two and a half inches. In some cases this symptom is absent at first, only showing itself after an interval of a few days; under these circumstances it is probably due to the fact that the periosteum and reflection of the capsule, which invest the neck, remained untorn at the time of the accident, but subsequently gave way as the result of some movement of the fragments, or owing to inflammatory softening of their structure; or the fragments, which were originally impacted, may have become loosened and separated.

7. Eversion of the limb, the result partly of muscular action, but mainly of the weight of the leg, which causes it to fall or roll outwards; in exceptional cases the limb is found to be inverted.

8. Loss of power in the limb, which is usually complete. Occasionally, when the periosteum and reflection of the capsule which invest the neck of the bone are untorn, the patient may be able to raise the limb and even stand or walk about, though with considerable pain and difficulty.

Union in this fracture is, as a rule, simply fibrous, or it does not occur at all, a false joint forming

between the ends of the bone; in most cases, osseous union only occurs if impaction is present. This result is probably owing to the following causes: 1. The difficulty of keeping the fragments in perfect apposition and in a state of complete rest. 2. The presence of the synovial fluid between the fragments. 3. The small supply of blood to the upper fragment, viz. only through the ligamentum teres. The age and feebleness of the patient, and the atrophy and impaired nutrition of the neck of the bone may also conduce towards the same result.

In the **impacted** fracture, which is much less common, the lower fragment is usually driven into the upper one, *i.e.* the neck of the bone is driven into the head.

The *symptoms* are not so well marked; there is less eversion and less loss of power in the limb, so that the patient sometimes stands or walks, though with difficulty; crepitus is absent, and the shortening, which is present to the extent of $\frac{1}{4}$ to 1 inch, cannot be made to disappear on extension, unless the impaction is broken down and the fragments separated.

Union in this fracture usually takes place by osseous tissue, and the deformity is in most cases permanent.

Extracapsular fracture of the neck of the femur is usually the result of direct violence, and though it may occur at any age, is most frequently met with in males under fifty years of age, *i.e.* during middle life. The bone is broken at, or just outside, the line of insertion of its capsular ligament, and in most cases more or less splintering of the great trochanter is present, for the same force that causes the fracture also drives the neck of the bone into the cancellous tissue at the base of the trochanter and breaks it into fragments. The fracture may be either impacted or non-impacted, the former being most common, for the neck very

frequently remains firmly wedged into the trochanter and osseous tissue at the base of the neck. Owing to the fact that the fracture is generally the result of direct violence, *e.g.* a fall on the hip, considerable bruising and swelling of the soft parts is usually present about the joint.

In the *non-impacted* variety, crepitus is very distinct, and can be readily felt on laying the hand over the trochanter, especially if the limb is rotated at the same time ; shortening is present to the extent of from 1 to 2½ inches, but can be made to disappear on making extension on the leg ; the limb is everted.

In the *impacted* variety, crepitus is absent, unless considerable force is used and the fragments are separated ; shortening is present, but does not usually exceed an inch, and cannot be made to disappear on making extension, unless the impaction is broken down ; the limb is almost always everted ; there is less loss of power about the hip, the patient being sometimes able to stand, or even walk, though with considerable pain and difficulty.

Diagnosis.—An *impacted* fracture differs from a *non-impacted* in the following points : 1. Crepitus is absent. 2. Shortening is usually less marked, and does not disappear on traction unless the fragments are separated. 3. There is less loss of power in the limb, and the patient can often raise it, and even stand or walk, though with difficulty. 4. Evidence of direct injury to the soft parts about the hip is more commonly present. 5. Inversion of the limb, though rare, is more common in the impacted than in the non-impacted variety.

Severe *contusions* of the hip, when accompanied by eversion and loss of power in the limb, may at first sight simulate very closely a fracture of the neck of the femur ; but the presence of shortening, the altered position of the great trochanter, and the presence of

crepitus (unless impaction has taken place), will usually distinguish a fracture from a contusion. In exceptional cases and especially when occurring in old persons, a contusion of the hip may be followed after a time by interstitial absorption of the neck of the femur, and under these circumstances slight shortening of the limb may gradually be produced.

When a person, the subject of *chronic rheumatic arthritis of the hip*, receives an injury to the parts about the joint, the shortening of the limb, which often exists, and the presence of crepitus from the rubbing together of osteophytes, may cause the condition to simulate fracture of the neck of the bone. The history, however, of the case, the fact that other joints are frequently affected, and that the patient suffered from pain and stiffness about the hip, with possibly some shortening of the limb prior to the accident, will usually serve to distinguish the true nature of the injury.

From a *dislocation* of the hip a non-impacted fracture may be distinguished by the presence of crepitus, the mobility of the limb, and the fact that the head of the bone cannot be detected in any of the situations in which it would be found in that injury. In impacted fracture with inversion of the limb, the injury may be confounded with a dorsal or sciatic dislocation of the femur, as there is an absence of crepitus, the movements of the joint are restrained, and the position of the leg is somewhat similar. The absence of the head of the bone from the dorsum ilii or sciatic notch, and the free movement of the limb, especially under anæsthesia, will, however, usually distinguish a fracture.

Separation of the upper epiphysis of the femur, which lies completely within the joint, has been described, but is of somewhat doubtful occurrence.

Treatment.—In *non-impacted intracapsular fracture* an attempt should be made to bring the

fragments into apposition, and to maintain them so, in the hope that osseous union will occur. To effect this, extension should be applied to the limb by means of a weight, in the way described in cases of fracture through the shaft (page 72); the patient should be kept in bed for six or eight weeks, and some form of support or stiff bandage afterwards worn for about the same period. As, however, this injury is usually met with in old persons, who in many cases will not bear long confinement in the recumbent position, owing to a tendency to the formation of bed-sores or the supervention of hypostatic pneumonia, it will often be necessary after two or three weeks, or even less, to allow them to get about on crutches, wearing either a stiff bandage or a Thomas's splint, such as is often used in cases of morbus coxæ; under these circumstances the union will probably be fibrous, and the patient will in consequence be left with a weak or shortened limb, more or less lame for the remainder of life. Some surgeons, instead of employing any special apparatus, simply support the limb on pillows, or between sandbags; others, again, make use of the double inclined plane.

In *non-impacted extracapsular fracture*, extension by means of a weight (page 72) should always be employed, and in cases where there is much splintering of the ends of the bone, a bandage round the hips will often be found useful in keeping the fragments in apposition. Firm osseous union will almost always take place.

In *impacted fractures of the neck* no attempt should be made (especially in the intracapsular) to loosen the fragments and restore the limb to its proper length. Osseous union generally results, even in old people, but the limb is left permanently shortened, and usually somewhat everted. All that is necessary is to keep

the part at rest by means of a long outside splint, no extension being required, unless with the object of keeping the limb level and parallel with its fellow.

Great trochanter.—Separation of the great trochanter is met with as an independent injury, and also as a complication of extracapsular fracture. When occurring by itself, the symptoms of this injury are mobility of the trochanter, with crepitus, which is usually distinct, unless the trochanter is drawn upwards and backwards on to the dorsum ilii, where it may form a distinct projection; more or less pain and swelling are present about the hip, as the fracture is always the result of direct violence. If accompanied by fracture of the neck of the femur, evidence of that injury will also be present.

Separation of the epiphysis of the great trochanter is rarely met with.

Treatment.—A bandage round the hip, or some form of cap moulded to the part, will generally be found useful in keeping the fragment in position; the limb should also be kept at rest by means of a long outside splint.

Shaft.—The shaft of the femur may be fractured at any part of its course, its middle third at a variable level being the commonest situation. The line of fracture may be either transverse or oblique, and, in exceptional cases, longitudinal and almost parallel with the long axis of the bone, or even of a spiral nature. The injury, which is usually the result of indirect violence, is accompanied by well-marked symptoms; there is, as a rule, considerable shortening with eversion of the limb, loss of power, increased mobility, and crepitus; more or less deformity, due to the displacement of the fragments, is usually present.

In the upper third, where the line of fracture is

often oblique, the upper fragment is drawn forwards and outwards, and also everted, while the lower one is drawn upwards and inwards, so that its fractured end lies above, behind, and to the inner side of that of the upper one; rotation outwards of the lower fragment is almost always present.

In the middle third the displacement is often much the same, though it will vary somewhat with the obliquity of the fracture.

In the lower third the upper fragment is drawn slightly forwards and inwards, the lower one upwards

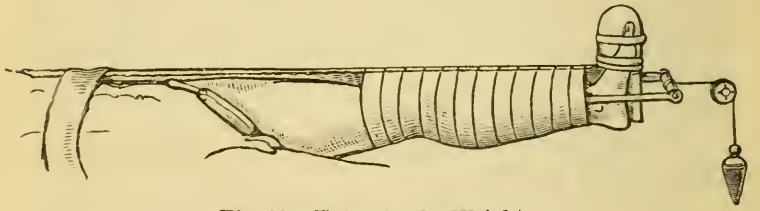

Fig. 11.—Extension by Weight.

and backwards, behind the lower end of the upper fragment.

Treatment.—Fracture through the shaft of the femur may be treated in many different ways.

Extension by a weight (Fig. 11) is a plan very universally adopted at the present day. A long strip of plaister is applied to each side of the leg as high as the knee, a loop being left beneath the sole of the foot; it is kept in place by short pieces of strapping which encircle the leg transversely, and over these a bandage should be carried from the toes up to the knee, in order to fix the strapping and at the same time prevent any swelling of the foot. To prevent the strapping from chafing the skin, a thin flannel or domette bandage may be first applied to the limb beneath it. To obtain a firmer hold on the limb, some surgeons carry the longitudinal strips of strapping above

the knee, but not so high as the seat of fracture: to fix them, several turns of a bandage, or one or two pieces of strapping (not applied too tightly), are then carried round the lower part of the thigh, just above the patella. By this means there is less chance of the strapping slipping, and as extension is made from the lower part of the thigh as well as from the leg, there is less strain on the knee than if extension is made from the leg alone.

A piece of wood (in length from one to two inches greater than the distance between the malleoli) should be fixed transversely in the loop left beneath the sole, so as to form a kind of stirrup, and take off all pressure from the sides of the foot and ankle. A strong cord is fastened by one end to the centre of the stirrup, and carried over a pulley arranged at the foot of the bed. A weight, varying in an adult from five to twelve pounds or more, is attached to the other end of the cord; this, if it acts in a line with the axis of the limb, will make extension on the lower fragment, and thus overcome the contraction of the muscles, which tend to draw it upwards. Counter-extension may be made by a perineal band attached above to the head of the bed, but in most cases the weight of the patient's body will be sufficient, if the foot of the bed is slightly raised. To steady the limb, a long, straight, outside splint should be applied, reaching from the side of the chest to the foot, and three short splints, fixed by means of straps (so they are readily removable for the purpose of examining the fracture) to the front, back, and inside of the thigh, will also be useful in assisting to maintain the fragments in position. The tendency to eversion of the limb should be prevented, either by fixing a horizontal cross bar to the lower end of the long splint, or by laying a sand-bag along its outer side.

Elastic extension is a modification of the preceding method; one end of a piece of strong indiarubber tubing being attached to the stirrup, the other end to the lower extremity of a Liston's long splint, counter-extension being made by a perineal band, as in the manner next described.

Liston's long splint and perineal band (Fig. 12) is much less frequently used at the present time than it was some years ago. A long, straight splint, notched at its lower end, and reaching from the axilla to about four inches below the sole, is first fixed to the foot and ankle by a figure of 8 bandage, which

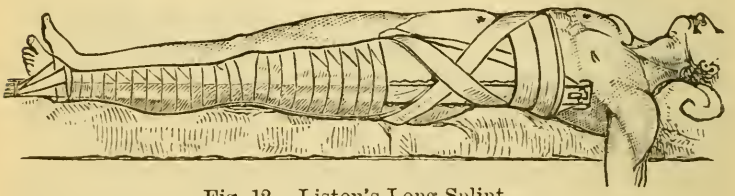

Fig. 12.—Liston's Long Splint.

passes through the notches at its lower extremity. The fragments having been brought into position by traction on the leg and splint, counter-extension is made by means of a perineal band, *i.e.* a well-padded bandage, which passes in front of the groin and behind the buttock, and the ends of which are passed through two holes at the upper end of the splint, where they are securely tied and tightened up from time to time, as the bandage becomes slackened.

This method has several disadvantages as compared with extension by a weight, for the pressure of the perineal band is very liable to produce excoriation of the skin, and its application is often painful. Traction being made merely from the foot and ankle, considerable pressure is exerted upon those parts, and at the same time the foot becomes extended, so that

not only is the position irksome, but it is often followed by stiffness and weakness of the ankle joint from stretching of its anterior ligament. When a weight is employed the perineal band is not required, extension is made from each side of the leg, and the foot remains at a right angle with the leg, in a position which is comfortable for the patient, and not likely to be followed by stiffness of the joint.

Desault's long splint differs from Liston's in the fact that its lower extremity, instead of being notched, has a lateral foot piece.

Vertical extension (Fig. 13), recommended by Bryant, is very useful in the case of young children, where it is always difficult to keep the apparatus employed free from contact with urine and fæces. In this method, both limbs are swung at a right angle to the trunk from a bar fixed over the bed, the weight of the body acting as a counter-extending force.

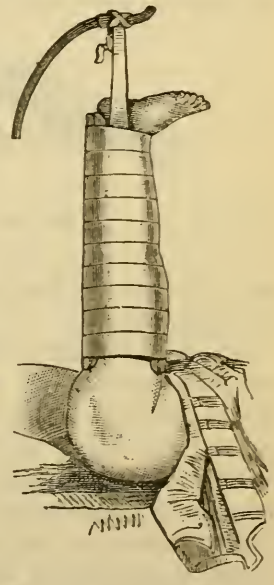

Fig. 13.—Vertical Suspension of Femur.

A Macintyre's splint (Fig. 14), or the double inclined plane, will often be found useful in fracture through the upper third of the shaft, where the upper fragment is tilted forwards; and again in fracture through the lower third, where the lower fragment is drawn backwards.

Another plan of treatment, sometimes adopted under similar circumstances, consists in flexing the thigh upon the trunk almost to a right angle, and the leg upon the thigh; the limb is then laid on its outer side on an angular splint, which

reaches from the hip to the ankle, and several short splints are also applied round the thigh.

Erichsen advocates putting up the limb at once in some immovable apparatus, *e.g.* a starch bandage with a thick layer of cotton wadding beneath ; this should be cut up and trimmed on the second or third day, and then re-applied. The advantage of this method is that the patient may leave his bed and get about on crutches after three or four days.

Space prevents more than a brief reference to the numerous other plans of treating this fracture, viz. :

Nathan Smith's anterior splint, a wire splint applied to the front of the leg and thigh, reaching

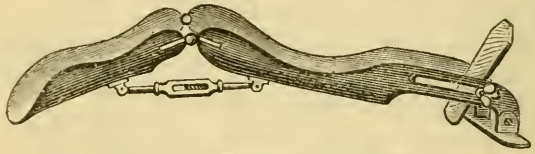

Fig. 14.—Macintyre's Splint.

from the foot to the groin, and by means of which the limb is swung.

Hodgen's splint, where the limb is supported on a cradle composed of cotton sacking attached to two lateral bars of strong wire, which reach from the upper part of the thigh to beyond the foot; the cradle is swung from an upright post at the foot of the bed, and traction is made upon the cradle, which, in its turn, makes extension on the leg by means of strapping attaching the leg to the lower cross bar of the cradle, which projects for some inches beyond the sole of the foot.

Thomas's splint, one similar to that used in cases of disease of the knee joint being sometimes employed, along with four short splints round the thigh itself.

Hammond's double splint, consisting of two long

straight splints, applied to the outside of both limbs, and connected by a cross bar below the feet.

Bryant's double splint, similar to that employed in cases of disease or excision of the hip.

In fracture through the shaft, union is generally effected in about eight weeks in the case of adults, but it is, as a rule, advisable to wear some form of stiff bandage for at least twelve weeks. In many instances some slight shortening of the limb will remain, even after the most careful treatment.

Lower extremity.—Fracture through the lower end of the femur may be *supracondyloid, i.e.* just above the condyles and not involving the knee joint. The symptoms are very similar to those of fracture through the lower third of the shaft, the lower fragment being drawn backwards by the gastrocnemius, so that its fractured end forms a projection at the upper part of the popliteal space.

Very frequently the joint is involved, the line of fracture being oblique, and running across either condyle, or through the intercondyloid space; or it may be T-*shaped*, running transversely above the condyles and also between them into the joint. Under these circumstances considerable swelling of the joint is usually present, owing to effusion of blood and fluid into its interior; crepitus and abnormal mobility can be readily detected on moving the joint, or upon grasping the condyles and moving them upon one another; when the condyles are separated, some increase in the breadth of the lower end of the femur is often apparent; in addition there will be pain, loss of power, etc., in the limb.

Separation of the lower epiphysis is sometimes met with in young subjects; the symptoms are identical with those of supracondyloid fracture, except that crepitus is less distinct or absent, owing to the smoother nature of the surface of the fragments.

This injury is liable to be followed by some arrest in the growth of the lower end of the femur.

Treatment. — In supracondyloid fracture, or in separation of the epiphysis, when the lower fragment is drawn backwards, the double inclined plane, or a Macintyre's splint, will be found useful; when the deformity cannot be overcome by flexing the knee in this way, division of the tendo Achillis, as recommended by Bryant, may be required in order to relax the gastrocnemius, the limb being afterwards put up in the same manner, or with extension by a weight, as in fracture through the shaft.

In cases of fracture through the condyles involving the knee joint, the limb should be fixed on a straight back splint, and the accompanying synovitis treated with some cooling lotion; lateral pressure, by means of side splints, will often assist in keeping the fragments in apposition. Passive movement should be commenced in about six weeks, otherwise considerable stiffness of the joint will probably result.

In cases of compound fracture involving the knee joint, amputation will often be required; the surgeon must, however, be guided by the age and general condition of the patient, as well as by the severity of the local injury.

THE PATELLA.

Fractures of the patella may be transverse, oblique, vertical, or star-shaped, and comminuted.

Transverse fracture, the commonest variety, is generally the result of muscular action, the bone being snapped across the condyles of the femur by a sudden and forcible contraction of the quadriceps extensor, when the knee is bent, as during an attempt to save the body from falling backwards; in many cases the line of fracture is not directly transverse, but somewhat oblique.

Vertical and comminuted fractures are always due to direct violence, *e.g.* a fall or blow upon the knee.

Symptoms.—In transverse and slightly oblique fracture there is usually more or less separation of the fragments, increased on bending the knee, the upper one being drawn away from the lower by the muscles attached to it; if seen directly after the accident, a distinct gap or depression will often be found in front of the joint between the fragments, and at the bottom of this the condyles of the femur can sometimes be felt. There is inability to stand and extend or raise the leg; crepitus cannot be distinguished unless the upper fragment is drawn down and brought into apposition with the lower one. If some hours have elapsed, an effusion of blood (hæmarthrosis) or synovial fluid, or a mixture of both, takes place into the interior of the joint, which becomes swollen and distended, and under these circumstances the depression between the two fragments, which become more widely separated, disappears, and may be replaced by a distinct bulging; at the same time the joint becomes more or less hot and inflamed, and evidence of synovitis appears. In exceptional cases, where there is no laceration of the periosteum and fibrous tissue investing and overlying the patella, separation of the fragments may not occur.

In vertical and comminuted fractures there is usually little separation of the fragments, and under these circumstances crepitus can be readily detected.

Mode of union.—In vertical and comminuted fractures, and in transverse, when, owing to the periosteum remaining untorn, there is little or no separation of the fragments, osseous union as a rule readily takes place.

In most cases, however, of transverse fracture, difficulty is experienced in keeping the fragments in immediate apposition, for one or more of the following

reasons; viz. 1. The contraction of the quadriceps extensor drawing away the upper fragment.* 2. Accumulation of fluid (blood or synovial) in the joint, distending it and consequently tending to separate the fragments. (That this is so, is proved by the fact that the difficulty in approximating them is usually in proportion to the amount of swelling.) 3. Interposition of blood clot, or of the fibrous and aponeurotic structures which overlie the patella, between the fragments.

The result is that union is generally effected by fibrous tissue, and as this usually tends to yield and stretch, the fragments of bone become, after a time, separated from one another, often to the extent of several inches, so that a weakened, and in some cases a more or less useless, limb remains. In exceptional cases, even when the fracture is treated in the ordinary way by means of splints, true osseous union is said to occur; but this result is extremely rare unless the joint is opened and the fragments wired together in the way described.

Treatment.—In vertical and comminuted fractures, where there is not usually much, or any, separation of the fragments, the limb should be kept on a straight back splint, and some cooling lotion applied over the knee.

In transverse fracture, where the fragments are generally widely separated, some means must be taken to bring them into apposition and to maintain them so, in the hope that close fibrous, if not osseous, union will result.

The leg should be extended on the thigh, and the thigh flexed on the trunk, by means of a long back

* According to Mr. J. Hutchinson, spasm of the muscles only causes separation at the moment of the accident; as soon as the limb is at rest in bed. its agency ends (*Brit. Med. Journal*, Nov. 10, 1881).

splint with a foot piece, the lower end of which is raised, in order to relax the rectus muscle, which, if it remains contracted, helps to draw away the upper fragment. Some surgeons, on the other hand, keep the limb in a horizontal position, believing that the muscle soon becomes relaxed and ceases to act.

If seen immediately after the accident, and before any effusion has taken place, the fracture may be put up at once; if, however, some interval has elapsed and the joint has become swollen and painful, the necessary pressure could not at once be borne. Under these circumstances an ice bag or an evaporating lotion should be applied to the knee, and then in the course of a few days, when the inflammatory symptoms have subsided, some means must be adopted to bring the fragments into apposition.

The usual plan is to draw down the upper fragment by a broad strip of strapping, carried across the limb just above it, and then diagonally downwards and forwards round the splint; a pad of lint should be interposed between the strapping and the limb above the upper fragment, so as to assist in pressing it downwards and at the same time prevent ulceration of the skin from the pressure of the strapping directly upon it. Another strip of strapping should be then carried in the reverse direction round the lower fragment and splint, and in this way the two fragments can generally be brought into apposition with one another.

To fix the strapping, a figure of 8 bandage should be carried above and below the knee, and to prevent both bandage and strapping from slipping, notches may be cut, or two nails fixed, on either side of the splint above and below the centre of the joint. In cases where the edges of the fragments tilt forwards and tend to separate, a third piece of strapping, carried transversely round the limb, directly over the

fragments, with a pad of lint intervening, will sometimes be found useful.

The splint should be kept applied for six to eight weeks; at the end of this period it may be left off, and the patient allowed to get about on crutches, wearing a stiff bandage to prevent any flexion of the joint. This should be worn for from three to six months; and then, if firm union appears to have taken place, the patient may begin to very gradually bend the knee. In most cases, however, the knee will be left more or less permanently weakened, as the uniting medium, which is usually fibrous, generally tends to yield; under these circumstances, if a leather knee-cap is worn, it will afford considerable support, and materially increase the usefulness of the limb.

Many other plans of treatment may be adopted with the object of bringing the fragments into apposition; instead of ordinary strapping, indiarubber bands are sometimes used; leather straps may be passed transversely round the limb above and below the fragments, and then approximated by means of longitudinal straps; a piece of strapping may be fixed round the limb above the upper fragment, and traction downwards made upon it, by means of elastic extension, or by a cord and weight suspended over a pulley at the bottom of the bed.

Another method consists in applying a long strip of strapping to the front of the limb, and fixing it by transverse slips and a bandage, a loop being left free over the knee; pads of lint are placed beneath the strapping, above and below the fragments of the patella. A piece of stick is passed through the loop, which is then twisted up until the fragments are drawn into apposition.

Malgaigne's hooks are not often employed at the present day, on account of the pain and irritation, with a tendency to suppuration, which they often

produce. They consist of a pair of double hooks, which are passed through the skin, fixed in the two fragments, and then approximated by means of a screw worked with a key. A modification of this plan is, however, sometimes adopted, the hooks being fixed into pieces of strapping passed round the limb above and below the fragments, instead of into the skin and bone itself.

Some surgeons put up the limb at once, or as soon as the swelling has subsided, in a stiff bandage, the fragments having been first brought together by strips of strapping in the way described. The advantage of this method is that it does not necessitate confinement to bed, the patient being able to get about on crutches after a few days.

When the joint is distended with fluid, another plan consists in drawing off the fluid with an aspirator, instead of waiting for it to become absorbed. Care should always be taken that the instruments used are perfectly clean, and it is advisable that the operation should be performed with careful antiseptic precautions.

Subcutaneous division of the insertion of the quadriceps extensor into the patella, as well as of the ligamentum patellæ, has also been adopted in a few cases with the object of ensuring perfect apposition of the fragments.

Laying open the joint and wiring the fragments has recently been advocated by Sir Joseph Lister,* and is a plan of treatment which has now been adopted in a large number of cases with considerable success.

The operation, which should always be carried out under the most careful antiseptic precautions, is performed in the following way: A longitudinal incision is made over the centre of the joint, which is opened, and the fragments of the patella are

* *Brit. Med. Journal*, 1883; vol. i., p. 855.

exposed; any blood clot which is present in the joint or between the fragments is turned out, and the fragments themselves are cleared of the aponeurotic and fibrous tissue, which is often found lying in between and over their broken surfaces. Each fragment is then bored obliquely with a drill, taking care not to reach its cartilaginous surface. Sutures of silver wire are then passed through the drill holes, and the fragments having been drawn together, the ends of the wire are twisted, cut short, and then hammered down on the bone, where they may be allowed to remain permanently, without causing any irritation. Free drainage should be provided for by the insertion of tubes in openings made at the back of the joint on either side.

If all goes well, firm bony union will result, and the movements of the joint will be more or less completely restored. The operation, however, is one which should not be lightly undertaken, nor without the most careful antiseptic precautions; it should always be borne in mind that the usual plans of treatment, if carefully carried out, give, as a rule, very fair results. Wiring the fragments has in several cases been followed by suppuration in the joint, and, as a consequence, the limb, and even the patient's life, have been lost; or if, after this complication (*i.e.* suppuration), recovery has taken place, the knee has been left more or less completely anchylosed.

The operation is therefore, perhaps, more applicable for old cases of fracture, where, in consequence of the fibrous tissue, by which union has been effected, having given way, the fragments have become separated, and the limb in consequence rendered more or less useless. Under these circumstances the fragments should be exposed, and their broken surfaces refreshed and brought together with silver sutures in the way described.

The Leg.

Tibia and fibula.—Fractures of the *tibia and fibula* are of frequent occurrence, it being more common for both bones to be broken than for one to be fractured by itself. When due to indirect violence, the most common cause of fracture in this situation, the tibia usually gives way at its weakest part, *i.e.* about its lower third, and the fibula at a slightly higher level; when due to direct violence, the bones are broken at the spot where the violence acts. In some cases, and especially when involving the upper part of the bone, the line of fracture is transverse, and under these circumstances the displacement of the fragments is often very slight. Much more commonly the line of fracture is oblique from above and behind downwards and forwards, and from without inwards, so that the upper fragment projects forwards beneath the skin (often piercing it and rendering the fracture compound), the lower fragment being drawn upwards behind it by the muscles of the calf.

The *symptoms* of this injury are usually manifest; in transverse fracture there is often very little deformity, but when it is oblique there will be the sharp projection of the upper fragment beneath the skin, with mobility, crepitus, pain, and loss of power in the leg.

In fracture of the **tibia alone**, which is often the result of direct violence, the line of fracture is frequently transverse, and under these circumstances the symptoms may not be very obvious, for the fibula, remaining unbroken, acts as a splint, and tends to prevent much displacement from taking place; in most cases, however, crepitus can be detected on manipulating the limb, and upon running the finger along the subcutaneous edge of the tibia some slight irregularity can usually be detected at the seat of fracture.

Fracture of the internal malleolus is a common complication of Pott's fracture of the fibula.

Separation of the upper and lower epiphyses of the tibia are described as rare injuries.

Fracture of the **fibula alone** is often met with as the result of indirect violence, the bone usually giving way through its lower third; less frequently it is due to direct violence, the fracture then taking place at the spot where the force acts.

The *symptoms* of this injury are often obscure, for there is usually very little displacement of the fragments, and the patient can occasionally walk without much pain or difficulty. Crepitus and mobility can, however, usually be detected, if pressure is made alternately on either side of the suspected seat of fracture, or if the foot is rotated with one hand, while the fingers of the other are placed over the point where the bone is broken.

Pott's fracture is the term applied to a fracture of the lower end of the fibula, associated with a dislocation outwards of the foot at the ankle joint. In this injury, which is usually the result of a sudden slip or twist of the foot outwards, the bone is broken from two to four inches above its lower extremity, the ends of the fragments being driven inwards; the articular surface of the astragalus is displaced from the tibia, the foot being dislocated outwards at the ankle joint; in some cases the inner malleolus of the tibia is also fractured, in others the internal lateral ligament is ruptured.

The signs of this injury are usually obvious; a well-marked depression can be felt at the seat of the fracture of the fibula; the foot is twisted outwards, and its sole is everted by the peronei, owing to the fact that the fibula no longer offers any resistance to their contraction; the inner malleolus, if unbroken, projects prominently beneath the skin; if separated

the detached fragment can be readily felt, with a depression above it, and crepitus is easily obtained; the heel is drawn up by the muscles of the calf (Fig. 15).

Dupuytren's fracture of the fibula is a rare injury, in which there is not only fracture of its lower extremity, but also laceration of the strong inferior tibio-fibular ligaments (which remain intact in Pott's fracture); in some cases, a slip of the tibia is torn off with the ligaments, remaining connected with the lower fragment of the fibula. In addition, the foot is displaced upwards and outwards, and the tibia is sometimes forced through the skin on the inner side of the ankle, so that the fracture is rendered compound.

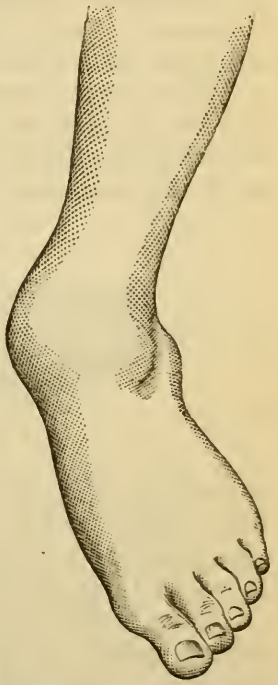

Fig. 15.—Pott's Fracture. (From Pick's "Fractures and Dislocations.")

Treatment.—Most cases of fracture of the tibia and fibula, or of either bone alone, may be treated on a straight back splint, with a foot piece for the sole at right angles to it, and two side splints; in the application of these, there are certain rules which should be observed, viz.: 1. The joints above and below the seat of fracture, *i.e.* the knee and ankle, should be fixed by the splints. 2. The inner border of the patella, the internal malleolus, and the inner side of the great toe should be in the same line. 3. There should not be any irregularity in the crest of the tibia. 4. The foot should be kept at right angles with the

leg. 5. The heel should neither be allowed to drop nor raised too high, and its under surface should be well in contact with the foot piece. 6. Pressure should be taken off the back of the heel by means of an opening in the back splint beneath it, and by a pad placed between the limb and the splint, just above it. 7. The seat of fracture and the toes should be left uncovered. 8. No bandages should be applied beneath the back splint.

The fracture should be kept in splints for three or four weeks, and some form of stiff bandage afterwards worn for about the same period. When there is not much displacement of the fragments, and an absence

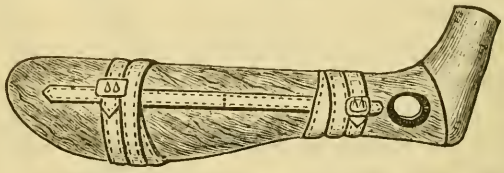

Fig. 16.—Cline's Splint.

of bruising or swelling of the soft tissues, the limb may at once be put up in some form of stiff bandage, *e.g.* plaster of Paris, or a Croft's splint, and the patient in two or three days allowed to go about on crutches.*

Some surgeons use Cline's splints (Fig. 16), viz. lateral splints with foot pieces; if employed, care should be taken that the foot piece is at right angles with the side piece, not at an obtuse angle, as is generally the case, otherwise, the foot being kept fixed with the toes pointed, considerable weakness and stiffness of the ankle will afterwards remain, from the stretching of its anterior ligament.

* In applying a stiff bandage to the lower extremity, whether in cases of recent fracture or after removal of splints, care should always be taken that the foot is kept at right angles with the leg while the bandage is setting.

Macintyre's splint (Fig. 14) is often employed, and by means of the screw behind, it may be applied with the limb straight or bent at the knee.

The "fracture box," or "box splint," is useful when the soft tissues are much bruised and swollen, and also in some cases of compound fracture; it consists of a board with a foot piece and movable sides, forming a kind of box in which the limb is supported on a pillow.

If the limb, after being put up in splints, is suspended in a swing, it will be more comfortable for the patient, as he will be able to move it as he lies in bed without disturbing the fracture; it may be swung by straps or bandages from the bed-cage, which should also be used in order to keep the weight of the bed clothes off the limb, or one of Salter's swings may be employed. If the limb is not suspended, sand-bags should be laid on the bed on either side of it in order to steady it.

When there is much displacement of the fragments and difficulty is experienced in keeping them in position by any of the preceding methods, it will often be found that laying the limb on its outer side with the hip and knee bent will prove successful, for in this posture the muscles of the calf, which are the chief agents in producing the deformity, become relaxed. Occasionally subcutaneous division of the tendo Achillis may be required with the same object.

In *Pott's fracture* there is, in addition to fracture of the fibula, the dislocation outwards of the foot, which has to be corrected.

Some surgeons treat this fracture with a back splint and two side splints; but when put up in this way there is often a tendency for the deformity to recur.

When the displacement of the foot is well marked, it is safer to use Dupuytren's splint, *i.e.* a straight

wooden splint, notched at its lower end, and reaching from the head of the tibia to about four inches below the sole of the foot (Fig. 17). This is applied to the inner aspect of the limb, a thick pad, not extending below the inner malleolus, being interposed between the lower part of the splint and the leg. The upper end of the splint having been bandaged to the limb, the thick pad is made to act as a fulcrum, across which the foot is drawn to the lower part of the splint; to this it is fastened by a figure of 8 bandage carried round the ankle and foot and through the notches at its lower end. This bandage should not be carried round the ankle higher than the external malleolus, otherwise it would press the fragments of the fibula inwards, and thus defeat the object of this plan of treatment, which is to draw the foot inwards and throw the broken ends of the fibula outwards. If the knee is bent, and the limb is either swung or laid on its outer side, the muscles of the calf will be relaxed, and in this way the tendency for the heel to be drawn up will be counteracted.

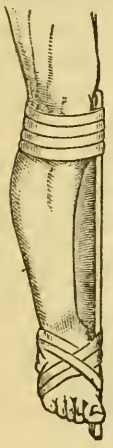

Fig. 17.—Dupuytren's Splint.

In the Manchester Infirmary a modification of Dupuytren's splint is sometimes employed, and I have myself frequently used it with very good results. It consists (Fig. 18) of an inside splint with a foot piece at right angles to it, for the sole. The foot is first bandaged to the splint, care being taken that the sole and heel are well in contact with the foot piece. The upper part of the splint is then drawn across the thick pad (which, being fixed above the internal malleolus, acts as a fulcrum), and bandaged to the leg below the knee. The advantage of this splint is that

the foot, by means of the foot piece, is maintained at a right angle with the leg, instead of becoming extended, as is frequently the case when the common Dupuytren's splint is employed; hence the stiffness and weakness of the ankle joint, which often remain after the latter is removed, from stretching of the anterior ligament, and from the long-continued faulty position of the foot, are to a great extent prevented.

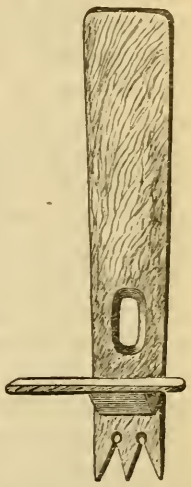

Fig. 18.—Splint for Pott's Fracture.

Pott's method of treating this fracture consists in flexing the knee to a right angle and laying the limb on its outer side; for this purpose an outside splint with a lateral foot piece may be employed, the pad of the latter being thicker than that of the leg piece, so as to press the foot inwards; to the inner side of the limb a straight splint is applied, reaching not lower than the ankle, the two splints being bandaged or strapped together.

In cases of Pott's fracture, where the displacement of the foot has not been completely corrected, considerable improvement will often follow the performance of osteotomy, *i.e.* subcutaneous division of the fibula and forcible straightening of the foot, the case being then treated as one of recent fracture.

When both tibia and fibula are broken, union, as a rule, takes place in from six to eight weeks, some form of apparatus being usually required for from eight to ten weeks; in the case of fracture of a single bone, six or seven weeks will generally be sufficient.

The Foot.

Fractures of the bones of the foot are of rare occurrence, except as the result of severe crushes; under

these circumstances several are usually involved, and the fracture is often compound.

Simple fracture of the **os calcis** is sometimes met with as the result of falls on to the heel; if broken transversely behind the attachments of the strong interosseous ligament, the detached fragment may be drawn up by the contraction of the muscles of the calf. In many cases, however, no displacement occurs, the strong ligaments maintaining the fragments in apposition, the only symptoms then present being pain and swelling about the heel, with crepitus on grasping the posterior part of the os calcis, and moving it from side to side. When the fracture is comminuted, the mobility of the fragments and the ready detection of crepitus will at once point to the nature of the injury. In some cases, as the result of sudden and forcible contraction of the muscles of the calf, the epiphysis, or even the posterior part of the os calcis, may become separated and drawn away. Simple fracture of the **astragalus,** as the result of indirect violence, is rarely met with, as are also fractures of the other tarsal bones. Fractures of the **metatarsal** bones and **phalanges** are always the result of direct violence, and resemble in their general symptoms the fractures of the corresponding bones of the hand.

Treatment.—When the posterior portion, or the epiphysis, of the os calcis is separated and drawn away by the muscles of the calf, an attempt should be made to relax the latter and bring the fragments into apposition, by placing the limb on an outside splint, with the knee flexed and the foot extended.

In fracture of any of the other bones, the foot should be kept at rest, either on a back splint with a foot piece, or by means of some form of stiff bandage.

II. DISEASES OF THE BONES.

James Greig Smith.

Inflammation.

Bone being a complex structure, made up of elements of very different character, shows, when inflamed, a corresponding variety in pathological result. Firstly, we have the periosteum, composed of an outer layer of fibrous tissue, and an inner layer of small active cells. Secondly, we have the bone proper, with its abundant and comparatively inert matrix, impregnated with earthy salts, and its scanty supply of vessels and sparsely distributed cell elements. Thirdly, we have the marrow, a highly organised, exceedingly vascular tissue, with very numerous cells and little or no matrix. As one or other of these tissues is involved we get three leading varieties of inflammation: *periostitis*, or inflammation of the periosteum; *osteitis*, or inflammation of the bone proper; and *endosteitis*, or inflammation of the bony marrow.

As, however, in every variety of inflammation of bone the process owes its existence and continuation mainly to the medullary tissue, whether it is massed together in the central canal, or carried along the vessels in the Haversian systems, or continued outwards under the periosteum, it will be readily understood that the varieties run into each other. Thus, periostitis usually accompanies osteitis, osteitis soon follows endosteitis, and so on. In the earlier stages the forms of inflammation are sufficiently capable of distinction, clinical as well as pathological. In their later stages the gross results may become so

Fig. 19.—Femur, showing effects of suppurative and of osteo-plastic periostitis. The shaft, in its upper two-thirds, is covered with a rough deposit of new periosteal bone; in the lower third, where suppuration had taken place, there is a piece of necrosed bone, overhanging which are several irregular pointed masses developed in the stripped periosteum which had formed the abscess wall. (Museum, Bristol Royal Infirmary.)

involved as to constitute in their totality diseases requiring separate description; such are *caries* and *necrosis*.

Periostitis.—By periostitis is meant an inflammation commencing in, and chiefly confined to the periosteum. It is met with in two leading forms:

1. *Simple local periostitis*, acute or chronic.

2. *Diffuse infective preiostitis*, always acute.

Simple local periostitis.—By this is meant a simple inflammation of an area of periosteum, rarely dangerous to life, and tending to recovery by resolution or after development of new bone or the formation of abscess.

Causation.—The simple form of periostitis nearly always arises either from local injury or from extension of inflammation from the underlying bone or overlying soft parts. The injury may be from a sudden blow, such as a kick on the shin, or from prolonged irritation, such as the pulsations of an aneurism. Chronic osteitis is always accompanied by periostitis, and an ulcer on the skin that is not distant from periosteum, as on the shin or scalp, will cause some degree of periosteal inflammation.

Pathology.—The appearances of periostitis are simply those

of inflammation of the two tissues which enter into its composition. Inflammation of the outer fibrous layer causes it to swell and become red or livid. It loses its purely fibrous character, and becomes pulpy and œdematous; it strips more readily from the underlying bone, and appears to be more intimately connected with the superimposed muscle. The layers of cells next the bone undergo proliferation, and these, with the inflammatory exudates, help to loosen the periosteal fibre from the bone. An excessive amount of proliferation in the "cambium" layer may elevate the fibrous layer some distance from the bone, stretching, or even tearing the vessels that pass between them, and so causing partial necrosis of the outer lamellæ.

The process may eventuate in several ways, which have been described as varieties, but are perhaps better described as simple *terminations.*

1. *Resolution.* — The inflammation may simply pass off in its early stages, no effects being perceptible beyond, perhaps, a slight production of new bone.

2. *Periosteal abscess.* — As a result of simple local inflammation an abscess, acute or chronic, may form between the fibre and the bone. This means that the vascular supply to the underlying bone has been cut off, and death (necrosis) of the outer layer of bone so nourished follows. An acute abscess is usually simply traumatic, and contains ordinary liquid pus. A chronic abscess has usually some predisposing influence, such as scrofula, when its contents are of the well-known cheesy nature, or syphilis, when the matter is greenish-yellow and thick.

3. *Osteo-plastic periostitis.*—The development of new bone is one of the most characteristic results of periostitis, and nearly always follows its existence in the chronic or subacute form. It is simply

an increase of the normal function following a morbid increase of histological activity. A low degree of inflammation is necessary to the production of new bone by periosteum. It is found especially underlying ulcers, in the neighbourhood of deep inflammations of the bone, around a foreign body, and under many other similar conditions. If found accompanying an acute inflammation, it is never in the centre of it, but in the more outlying areas, that the new bone is produced. These periosteal bony new growths are known pathologically as *osteophytes*, or more correctly as *periosteophytes*, and clinically as *periosteal nodes* (Figs. 19, 20, and 21).

Fig. 20.—Tibia and Fibula, showing the effects of osteo-plastic periostitis. The interosseous membrane is almost completely ossified, and the shafts of both bones are covered with rough periosteal new growth which is carried outwards on to the fibrous septa between the muscles. (Museum, Bristol Royal Infirmary.)

Symptoms. — Pain of a bursting or throbbing character is the most prominent symptom of acute simple periostitis. The pain is increased by pressure over the part, and especially by tapping, and is nearly always worst at night. There is some defined swelling in the overlying soft parts; the skin is either normal in colour or slightly dusky.

If acute abscess forms, the pain is intensified, and may be agonising; the swelling increases, and the skin becomes red. In chronic abscess there

is less pain, but the swelling will be more marked with vague fluctuation or bogginess. The skin in the early stages may be of normal colour, but later on it becomes mottled, dusky, or red, ultimately showing the ordinary signs of perforation by abscess. In osteoplastic periostitis, which is nearly always subacute or chronic, the swelling is hard and unyielding, and the pain may be slight and remittent. Pain is least marked in strumous periostitis; in syphilitic periostitis it is always most severe at night; in rheumatic periostitis the pain is shifting and uncertain as to locality and duration.

Predisposing causes, local as from injury or irritation, or constitutional as from syphilis, struma, or rheumatism, will be looked for to help in the diagnosis.

Treatment.—In simple acute periostitis the patient must be put to bed, the part elevated as much as possible, and cold applied either by ice or evaporating lotions. Hot fomentations or lead and opiate lotions may be used instead. If the pain is very severe a full dose of opium, and a liberal application of leeches to the part, will probably give much relief. Should the pain still continue, and the febrile disturbance remain unabated after twenty-four hours or so, the danger of suppuration must be avoided by a free incision through the periosteum down to the bone, either subcutaneously by a tenotomy knife, or through the soft tissues by a scalpel.

Fig. 21.—Section through the Shaft of a Femur, enormously thickened from osteo-plastic periostitis. (Museum, Bristol Royal Infirmary.)

When acute abscess has formed, immediate and

free incision is necessary. In chronic abscess connected with syphilis, opening may be delayed until a fair trial has been given to specific treatment. In strumous periosteal abscess it will be well, after opening, to scrape the denuded surface with a suitable instrument, as the underlying bone will probably be found carious.

In chronic non-suppurative periostitis, where there is, in all probability, some development of new bone, repeated blistering is likely to be most successful, though the application of the oleate of mercury has had good results. Iodide of potassium is supposed to be beneficial in promoting bony absorption. Subcutaneous section in various directions, or the use of the gouge, especially if there is much pain, may occasionally be recommended.

Diffuse infective periostitis, acute necrosis, acute diffuse periostitis.—This is a grave constitutional disease, locally manifested by septic suppurative inflammation of the periosteum, resulting in more or less extensive death of bone, and frequently attended with all the signs of acute septicæmia.

Causation.—The affection nearly always occurs before puberty, and in boys more frequently than in girls. Various local causes have been assigned, such as injury and exposure to cold and damp; but the ultimate cause is probably constitutional. It sometimes appears after the continued fevers, and frequently in connection with the strumous diathesis; but in a considerable number of instances it is met with in individuals who have shown no previous signs of disease.

Pathology.—The pathology of this disease is still obscure. Some surgeons maintain that acute necrosis is always a result of osteo-myelitis; others that it is a pure periostitis. It is certainly an inflammation of medullary tissue, and this may be

localised under the periosteum as well as in the central canal. Practically such a distinction holds good; for we meet with a superficial acute necrosis of part of the outer shell, such as would be caused by a periostitis, as well as with a necrosis of the whole shaft, such as would be caused by an osteo-myelitis.

The distinguishing marks of this form of periostitis are the rapidity and certainty with which suppuration supervenes, and the uniformity with which micro-organisms are found in the pus. The purulent fluid forces its way between the periosteum and the bone, completely severing the connection between the two, tearing through the nutrient vessels, and leaving the surface of the bone to die. The condition may be described as a septic abscess confined under great pressure between periosteum and bone. The results of such a condition in death of bone and septic infection of the system are readily understood.

Symptoms.—The symptoms are nearly always urgent. A sudden access of high fever, often ushered in with a rigor; profound constitutional disturbance, local deep-seated pain, with swelling or signs of suppuration in the soft parts overlying a bone, point to acute diffuse periostitis. At the outset local signs may be slight or absent; but, as the disease progresses, they become more urgent. Delirium is frequently present from an early stage.

The site is usually in one of the long bones, and especially in the tibia, femur, or humerus. The signs of inflammation, obscure at the beginning, in a very short time become marked with redness, puffiness, and œdema of the skin, quickly to be followed by evidence of suppuration. At this stage symptoms of septicæmia, often of the most aggravated form, may supervene; and the patient may die in a few days, or linger for weeks with abscesses in the joints or in other parts of the body. Not unfrequently, however,

and especially if the disease has been recognised and properly treated from the beginning, a favourable result ensues.

Treatment.—The only treatment likely to be of benefit is early and free incision of the periosteum, wherever pain or swelling may localise the affection. As a tendency to septicæmia already exists, the strict observance of the practice of antiseptics will be advisable. If done early enough, such incision is usually followed by a marked improvement in all the symptoms. Early incision not only minimises the risks of blood poisoning, but saves the bone from extensive denudation and consequent necrosis.

Supporting or even strongly stimulating constitutional treatment will be called for in all cases. No special drug is likely to be of benefit. The question of amputation, though it may arise, is not so likely to be pressing as in the allied disease of acute osteomyelitis.

Osteitis.—By osteitis is meant an inflammation in the substance of true bone, varying in intensity and duration, and ending in resolution, or in thickening of its tissue, or in various forms of degeneration.

Causation. — The simple forms of osteitis are usually caused by injury. Frequently a diathesis or cachexia, such as scrofula, syphilis, or rheumatism co-exists with special forms of osteitis, and is credited with being either the active or the predisposing cause. Exposure to climatic influences (cold, damp, malaria) has been known to produce the disease.

Pathology. — The effects of inflammation in bone are produced almost entirely through its medullary tissue. The bone cells proper take little, if any, part. Each Haversian system, with its artery, vein, nerve, lymphatics and delicate cellular tissue in the central canal, and its concentric lamellæ, arranged like the leaves of a roll of music around this canal,

may be regarded as an ossicle or long bone in miniature, repeating in itself in detail what occurs in bulk in the whole bone. The first steps are vascular engorgement, inflammatory exudation, and cellular hyperplasia in the soft tissues lying in the canal. This increased activity is associated with a rapid solution and removal of the bone substance. Where the bone is not compact, but areolar, the same thing goes on, but with more rapidity and vigour on account of the greater proportionate amount of the soft tissue. Bony rarefaction and cellular hyperplasia, always the initial result, may go on indefinitely to reach the dignity of a special variety of osteitis; *rarefying osteitis* or *caries*. Should the inflammation be very acute, the rapid cellular overgrowth causes strangulation of the confined vessels, and the bone which depends on them for vitality dies; *necrosis*. In the more chronic forms of inflammation the bone which is absorbed is replaced by new bone, often in excessive amount, causing ingrowths or outgrowths, with general increase in density; *osteo-plastic osteitis, osteo-sclerosis*. Occasionally, again, the inflammatory process results in a localised collection of pus in the midst of the bony tissue, which increases by absorptive distension of the outlying bone; *abscess of bone*.

Each of these processes, as being terminal varieties of more clinical importance than the simple initial inflammation, will receive separate consideration.

Symptoms.—The most important sign of simple osteitis is pain of a deep-seated boring or gnawing character, which is liable to exacerbations and remissions. The pain is usually worst at night, and is always increased by unrest or exercise. An elevated position of the inflamed part relieves the pain; this is well seen in inflammation of the bones of the leg or foot, where the pain, aggravated by walking, is at once relieved by elevation. There may be

slight dusky redness of the overlying skin, but sometimes there is abnormal paleness from œdema. Swelling of the soft tissues is usually slight; enlargement of the bone is late in appearing, and is chiefly an effect of extension of inflammation to the periosteum.

It is always difficult and often impossible to diagnose simple osteitis from simple periostitis. In osteitis the deep boring character of the pain, and its continuation in varying intensity over long periods of time, without much apparent effect on the soft tissues, are the leading guides. In periostitis the pain is more superficial, and steadily increases in severity without intermissions, while swelling rarely fails to manifest itself at a comparatively early stage. Percussion or tapping with the finger may be of assistance in forming a diagnosis. Tapping over the area of an osteitis causes a deep thrill of pain to shoot through the whole bone, which may last for some time afterwards; in periostitis tapping causes a temporary aggravation of the superficial pain only. Pressure considerably aggravates the pain in periostitis; it may not affect, or may even relieve the pain in osteitis.

Treatment.—The part must be put at rest, and elevated as much as possible. In the early stages of simple acute osteitis, the local abstraction of blood by leeching or cupping will usually relieve the pain and benefit the disease. Lead and opiate lotions, applied hot, are soothing. If the pain is very severe and the fever is high, drilling the bone in several directions, through a small incision made with a tenotomy knife, will nearly always afford relief and often effect a cure. Such drilling gives rest to confined and compressed exudations, relieves engorgement of vessels, and provides drainage. In chronic cases, rest, with repeated blistering, or the application of counter-irritants, is beneficial. The last resort in every case is removal of part of the surface of inflamed bone, by trephine or

gouge. No case ought to be allowed to drift into caries or necrosis or abscess, without a trial having been given to trephining or gouging.

The constitutional treatment is generally that of the fevered state. Benefit has been derived from the

Fig. 22.—Caries of the Bones of the Cranium. There is rarefaction, with destruction of bony tissue, but no development of inflammatory new bone. (Museum, Bristol Royal Infirmary.)

administration of mercury to the extent of ptyalism If the pain be very severe, opium is indicated. Any diathesis, rheumatic, gouty, syphilitic, or strumous, which may be supposed to influence or predispose to the complaint, is treated by its proper remedies.

Varieties and terminations of osteitis.—These, as being clinically more important than the

simple and typical form of inflammation of bone, are described as separate diseases. They are :

1. *Rarefying osteitis.* Known also as *inflammatory osteo-porosis*, and most frequently as *caries.*

2. *Osteo-plastic osteitis.* Known also as *sclerosis of bone.*

3. *Abscess of bone.*

4. *Necrosis*, or death of the bone. This, as being also a result of endosteitis, will be described after that disease.

Caries; rarefying osteitis; inflammatory osteo-porosis.—By caries we mean a chronic inflammation of bone attended with absorption or rarefaction of bony tissue, and increase of the cellular elements, which are liable to degenerate and become purulent.

Causation. — Constitutional weakness of some sort is usually the cause of an osteitis becoming rarefying or suppurative. The patient's health may have been weakened by want of proper food, or bad hygienic surroundings; most frequently a specific disease, particularly scrofula or syphilis, may be credited with the causation.

Pathology.—The essential features in the pathological anatomy of caries are absorption and replacement by proliferating medullary tissue of the systems and trabeculæ of bone. The compactness and density of the bony tissue are diminished, making the bone appear more porous when macerated, and more soft and friable when fresh (Fig. 22). Pathologically it is impossible to distinguish between a simple rarefying osteitis and a suppurative disintegrating caries; the one is a more advanced stage of the other.

Rarefying osteitis is most common in cancellous bone; that is, wherever red marrow is found. Its favourite sites are in the ends of the long bones, in the bodies of the vertebræ, and in the bones of the

feet and hands. Bearing in mind the undoubted similarity in structure and functions between red marrow and lymph-glandular tissue, and the fact that in scrofula both tissues frequently undergo changes that are almost identical and often associated, we can scarcely avoid the conclusion that caries is an effect of scrofulous lymphadenitis. The implication of bone is simply an accident of lymph-glandular tissue being placed in its meshes; the active cause must be sought in the inflamed marrow. Many other considerations, not the least important of which is the discovery of giant cells and tubercular bacilli in certain cases of caries, confirm the belief that strumous gland disease and fungating caries are in most respects identical.

Simple rarefying osteitis, owning no constitutional cause, and simply induced by traumatism, is not very common. In its purest form it is seen as a result of constant traumatic irritation, such as might be produced by the pulsations of an aneurism. There is here simple cellular overgrowth at the expense of the bony trabeculæ; the changes peculiar to the commoner strumous forms are absent.

The minute changes in rarefying osteitis are somewhat varied. There is always an excess of cellular growth, or granulation material of a somewhat degenerate type. The cells everywhere crowd the trabecular spaces, fill the Haversian canals, and occupy new channels, which are formed in all directions through the compact bone (Fig. 23). The bony tissue disappears in front of these granulations in different manners. In most situations it passively falls to pieces in small granules or portions of lamellæ along the natural lines of cleavage. Frequently it is absorbed in hollows or lacunæ (*Howship's lacunæ*), in each of which may be found large vigorous looking cells (osteoclasts), and occasionally the loop of a small

blood-vessel. Sometimes in the larger hollows are found masses of coherent protoplasm, containing several nuclei, and known as giant cells. Special forms of giant cells, not occupying lacunæ, with long processes, and often containing rod-shaped bacilli, are found among the granulations in tubercular caries.

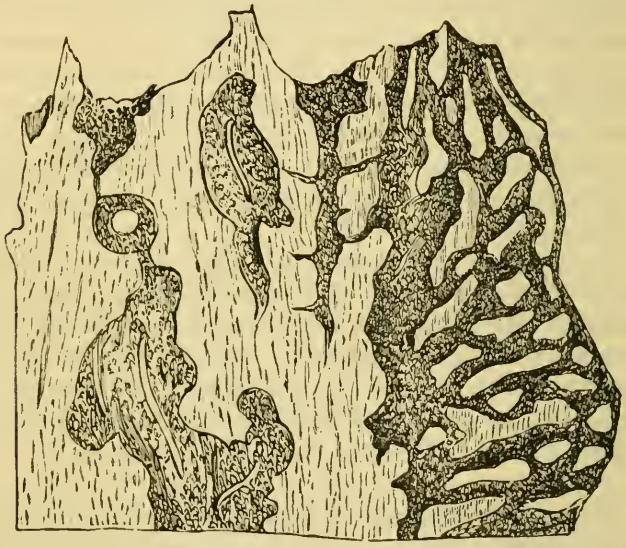

Fig. 23.—Section (× 50) through the protruding end of a Femur on a stump after amputation of the Thigh. On the right are seen the appearances of simple rarefying osteitis in compact bone; on the left is visible a considerable development of periosteal new bone of the usual areolar character.

In every case the bone corpuscles are essentially passive, simply undergoing fatty or granular degeneration in the enlarged and corroded lacunæ.

These minute changes may produce different gross results. Sometimes the granulations remain quiescent, or undergo a harmless fatty change, and there is no formation of pus; dry caries, or *caries sicca*. More frequently the granulations invade neighbouring

tissues, sprouting through the skin or into a joint; fungating caries, or *caries fungosa*. In the more active forms an area perishes, and this, set free by the action of the living granulations around it, is left as a piece of dead bone in the centre of the inflamed district; necrotic caries *caries necrotica* (Fig. 24).

Occasionally one or more abscesses form in the heart of the fungating granulations to become united in one pus-containing cavity to be presently described as *abscess of bone*.

Generally speaking, the final changes in rarefying osteitis resolve themselves into one or other of three groups:

(1) Simple resolution and return to health, as in some cases of hip joint disease.

(2) Caseation, fatty degeneration, or even calcification of the inflammatory products; conditions which may remain quiescent for years, but are rarely permanently harmless.

(3) Most common of all is breaking up of the granulations, and the formation of an open sinus through which the purulent matter and bony detritus are discharged.

The naked-eye appearances

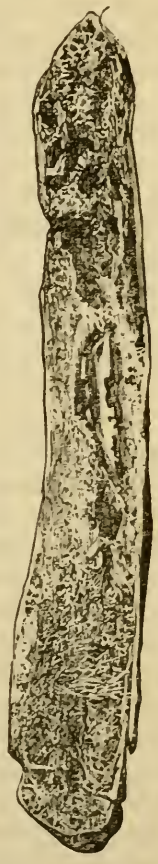

Fig. 24.—Femur affected in its upper and lower thirds with advanced rarefying osteitis, in its middle third with central necrosis. In the middle of the shaft a small piece of necrosed bone lies loose in a cavity surrounded by sclerosed bone, which is traversed by a long channel leading to an opening in the shaft higher up. (Museum, Bristol Royal Infirmary.)

of carious bone are characteristic enough. The whole tissue is softened, so that it may be cut with the knife or crushed between the fingers. Semifluid, fatty, or purulent material exudes from the surface on section or pressure; and small collections of pus or cheesy material are often found throughout the diseased substance. When macerated the increased porousness and fragility of the true bony material becomes very evident; a macerated carious bone may not weigh one-tenth of that which it ought to weigh when healthy (Fig. 22).

Symptoms. — The earliest signs of caries are simply those of chronic osteitis; it is impossible to distinguish the one from the other till evidences of suppuration appear. When, with a history of osteitis, redness, swelling, and obscure fluctuation come on in the soft parts, we may suspect caries. The same history with the disease localised near a joint, and followed by signs of inflammation in that joint, also indicates caries. Unequivocal signs appear after the abscess has burst or has been opened, when bare softened bone may be felt with a probe at the bottom of the abscess cavity. When the first collection of matter is discharged the abscess walls collapse, leaving a sinus leading down to the diseased bone, through which watery pus and bony detritus are discharged. Such discharge, if of long standing, is usually very fœtid. The granulations lining the sinus and overlying the diseased bone are usually of an unhealthy flabby nature, and merge imperceptibly into the surrounding skin, which is usually swollen and of a dusky red colour, overlapping the sinus with thin irregular margins. Occasionally, and particularly in caries of the bones of the hands and feet, the compact outer shell is considerably expanded and thinned out by the fungating granulations inside, forming one of the conditions

which used to be called *spina ventosa*. Such a condition is essentially a large chronic abscess in bone.

In caries of bones lying at some distance from the surface, as the spine, the hip, or the femur, the sinus may pursue a long and tortuous course through the soft tissues. In such cases, also, two or more sinuses may be found leading to the same diseased area.

Treatment.—In the treatment of caries attention to the constitutional element is of special importance. If the cause is scrofula, cod-liver oil and the iodide of iron are the most valuable medicinal remedies. Of equal value, however, are a varied and nourishing dietary, plenty of fresh air, and, if possible, an existence chiefly out-of-doors. For syphilis similar hygienic measures with iodide of potassium are indicated.

Locally there is but one treatment of value for carious bone; removal of it. Blisters, setons, absorbents, and the like are all useless; the only plan that promises success, if the disease resists constitutional treatment, is to remove the sluggish granulations entangled in the bony meshes along with the bone that retains them. Most frequently this can be done without interference with neighbouring tissues; but occasionally, as when the disease involves a joint, the articulation may have to be removed with the bone, or even the whole limb may have to be amputated. (*See* Diseases of Joints.)

The removal of carious bone is best conducted with the limb bloodless. The diseased bone is exposed by an incision, linear or T-shaped, or crucial, as seems most convenient. If the bone is very soft a Volkmann's spoon may suffice for its removal, but usually a gouge will be required to complete the excision of the diseased portions. An osteotrite or similar instrument will sometimes be of use. Scraping or gouging is to be proceeded with till marked

increase of resistance shows that healthy bone has been reached. In removing diseased portions that lie at a considerable distance from the surface, or dangerously close to important structures, the gouge forceps will be found a useful instrument. The unhealthy granulations along the sinuses are to be thoroughly removed by scraping, and the whole of the disease replaced as far as possible by healthy raw wounds.

In cases of great distension of the bony shell, as in scrofulous caries of the long bones of the hands or feet, it may be advisable to remove by scissors considerable slices of the bone and skin, leaving an open gutter to heal from the bottom by granulations. In a few instances it may be possible, with strict antisepticism, to get primary healing through filling of the cavity with blood clot; in the majority, however, we must expect a very gradual cure by the growth of granulations from the bottom of the scraped cavity.

The open tracts and cavities left after scraping are plugged with lint soaked in some trustworthy antiseptic, such as terebene or chloride of zinc solution. This prevents bleeding, which is sometimes free, and destroys any remaining fœtor. The plug may be removed at the end of twenty-four hours, and replaced by a simple external absorbent and antiseptic dressing. Perfect drainage supplemented by occasional syringing, and the insufflation of iodoform, will expedite the process of cure.

Osteo-plastic osteitis; osteo-sclerosis; sclerosis or thickening of bone.—By this is understood a form of chronic osteitis, attended by a development of new osseous tissue, which adds to the density, and sometimes as well to the size of the bone affected.

Causation.—It is impossible to specify any distinct

causative influence. In most cases it is simply the curative process of an ordinary osteitis run to excess. A foreign body, such as a bullet, embedded in a bone may produce effects which are clinically apparent only as sclerosis. Syphilitic inflammations of bone are liable to result in thickening. An area of sclerosis is found surrounding an abscess in bones.

Pathology.—There is no special histological lesion in sclerosis; the condition is at all points identical with the condensation and thickening of bone which follows up a rarefying osteitis that is getting well. The result is a general increase in the amount of formed bone, with corresponding diminution in the size of the spaces. Sometimes the encroachment on vessels is so great that they are obliterated, and a piece of bone becomes necrosed, and is cast off (Fig. 24).

Symptoms.—The symptoms are those of chronic osteitis, with, in addition, evidences of increase in the size of the bone. Pain is not usually severe, and is fugitive and uncertain. Except in association with syphilis, we clinically do not meet with simple osteosclerosis; it is nearly always a sequence of some other and recognisable form of inflammation, traumatic or suppurative. Sclerosis is always associated with the later stages of necrosis, and may be the cause of the wandering pains felt in the thickened and still inflamed bone. It exists for some time around the united ends of fractured bone, and in this situation may be the site of pain lasting over several years.

Treatment.—No very definite rules for treatment can be laid down. Comparative rest to the part, and the application of counter-irritants or blisters, are most likely to be of use. Mercury and iodide of potassium are supposed to be useful in this form of inflammation of bone, chiefly, no doubt, through their influence on syphilis, which is frequently a factor in sclerosis. In cases attended with much pain, or

signs of considerable inflammation, drilling in various situations may be of benefit.

Abscess in bone.—By this name is known a condition, usually chronic, in which a localised collection of purulent matter exists in the substance of a bone.

Causation.—The influences which make an inflammation become suppurative are probably the same for bone as for other tissues. Feebleness of constitution, and more especially the strumous diathesis, is made to account for most cases. In a few, however, mere acuteness of inflammation without any signs of general disease must be reckoned as causative. Micro-organisms have, in some instances, been found in the pus evacuated; this would suggest a septic source. A good many cases are supposed to originate in the breaking up of caseated tuberculous masses.

Pathology.—The early stages of abscess in bone are simply those of rarefying osteitis. When the cancellated tissue is completely absorbed, the cellular growth which is left simply degenerates into an abscess. The periphery of the abscess cavity is occupied by granulations which contribute to its enlargement by absorption of the surrounding bone and secretion of pus. In the more outlying areas, away from the focus of inflammation, there goes on an osteo-plastic osteitis, or thickening of bone, which tends to limit the extension of the abscess and to make its progress extremely chronic. In spite of this limiting sclerosis, however, the size of the abscess slowly increases, till it may attain to a diameter several times greater than that of the bone in which it is situated. In the centre of the abscess cavity a piece of necrosed bone may be found; but usually its contents are simple pus, curdy and unhealthy.

Symptoms.—In the early stages the signs of abscess in bone are those of deep-seated chronic

inflammation. The most prominent feature is pain of a severe boring or lancinating character, worst at night, and liable to exacerbations and remissions. There is usually tenderness, localised in one spot; and sharp taps on this spot considerably aggravate the pain. The pain may disappear for days or even weeks, but it always recurs, either spontaneously or after slight provocation.

At first there is no visible alteration in the overlying skin, but later a diffuse dusky redness, with some swelling, makes its appearance. When the abscess attains to considerable dimensions, the swelling and redness may be marked features; but relief is nearly always sought for and obtained before this. Some rise of temperature and other signs of abscess confined under tension will probably be found.

In the majority of instances the disease is found in the head of the tibia. The amount of matter present is usually very small, seldom more than a drachm, and very rarely so much as an ounce.

Treatment.—The treatment of abscess in bone is simply that of abscess elsewhere, evacuation. The limb is made bloodless by elevation, or by Esmarch's bandage, and the bone exposed by a suitable incision. The periosteum may or may not be elevated; on the whole it is perhaps best to remove it, as rapid growth of new bone over the abscess cavity is not desirable. The bone will probably be thickened and indurated, so that perforation will be somewhat difficult. Various methods of piercing the bone are in use. Trephining, gouging, perforation by bone drill, and linear osteotomy by Hey's saw, have all been recommended and successfully used. As good a plan as any would probably be by the combined use of the drill and the gouge, the drill being used to discover the situation of the abscess, and the gouge to enlarge the opening. A large drill is attached to an engine,

such as dentists use, and is pushed through the bone in the direction in which the abscess is supposed to lie. If pus does not flow through the hole first pierced, the drill may be pushed in several other directions till matter is met with. A probe is now placed in the hole made by the drill, and the gouge or trephine, guided by the probe, is made to remove a piece of bone sufficiently large to permit of the cavity being scraped, and to provide free drainage. Good results have been got from the use of Hey's saw alone; a longitudinal section of the bone, by saw, is very likely to enter the cavity, but most surgeons would prefer to enlarge the opening so made. The objection to the trephine alone is, that after a tedious operation, and the removal of a large piece of bone, the abscess cavity may not be reached. The preliminary use of the rapidly working bone drill obviates this risk.

The cavity thus freely exposed is cleared of its contents, and scraped or mopped out with some powerful antiseptic. Syringing with antiseptic lotions, insufflation of iodoform, and provision for free drainage would probably represent the best subsequent treatment. If the abscess is not putrid, the complete antiseptic method will give the best results. The process of cure must in any case be slow, as the dense bone surrounding the cavity gives only scanty blood supply to the granulations by which the cavity must be filled, and through which the new bone must be developed.

Endosteitis; osteo-myelitis; medullitis; inflammation of the marrow or medulla of bone.—Inflammation of the bony marrow occurs in two leading forms: (1) Simple osteo-myelitis, acute or chronic; (2) Diffuse septic osteo-myelitis, always acute.

Simple osteo-myelitis is not of much clinical importance. In its acute form it is always the result

of injury, and more particularly of fracture. Some degree of osteo-myelitis is essential to the healing process in fracture; in compound fractures the inflammation may be suppurative, and may extend some distance up the bony canal.

In its chronic form osteo-myelitis specially lays hold of the pink marrow at the ends of the long bones. The important part which the marrow plays in all forms of bony inflammation has already been pointed out, and need not further be dwelt upon. All such inflammations in the marrow at the ends of the long bones are intimately connected with one form of so-called scrofulous joint disease.

Diffuse septic osteo-myelitis; acute diffuse osteo-myelitis; acute necrosis.—These names have been given to an acute septic inflammation diffused through the marrow of long bones, and usually terminating in death of the shaft.

It is closely related to and probably pathologically identical with the disease already described as acute suppurative periostitis, with the synonym also of acute necrosis. The clinical features differ according to the situation of the marrow affected, periosteal or endosteal. A third variety of septic osteo-myelitis, described by German writers as idiopathic and infective, is probably identical with the disease now to be described, and will not be separately considered.

Causation.—Diffuse septic osteo-myelitis occurs under two distinct conditions; firstly as a result of traumatism, where the medullary cavity is opened and visibly exposed to septic influences; and secondly, when it is found almost uniformly before maturity, and more especially in childhood, where there is no open wound, and no visible passage for the entrance of micro-organisms. The first variety is now most frequently met with in military surgery, as a result of gun-shot wounds. In former times it was a common

result of compound fractures treated in civil hospitals. Arising in children without visible traumatic cause, nothing is known of its remote etiology, though its immediate origin is undoubtedly to be explained by the production of micro-organisms. In some cases it is a manifestation of general septicæmia, and its occasional occurrence in several instances in the same hospital ward suggest an infective origin.

Pathology.—When exposed to septic infection the marrow in long bones is only too favourably placed for the diffusion of violent inflammation. Confined within a rigid shell, and in free communication from end to end by its abundant blood and lymph vessels, the medullary tissue, when inflamed, suffers double disaster from the rapidity of the spread of the inflammation, and the impossibility of relief by swelling. Its soft sensitive tissues are strangulated by their own proliferation, and the bone, cut off from its most important blood supply, suffers death. In the compact bone the incompressible veins may serve to carry infection to the system, and fatty embolism from a similar source is not unknown.

The naked-eye appearances of a bone affected with acute osteo-myelitis are striking and characteristic. The compact tissue is pink generally, or in patches; the cancellous bone is of a bright or dusky red colour, and the marrow is transformed into a semifluid, often stinking material, made up of pus and diffluent fat, and exhibiting red streaks and patches representing injected vessels and extravasated blood. In some cases, especially in the non-traumatic variety, a subperiosteal abscess forms. This is usually found where the compact bone is thinnest, and its foramina most numerous; that is to say, above the epiphyses, near the joint. In this situation suppurative inflammation of the epiphysial cartilage is peculiarly liable to take place, leading to disjunction of

the epiphysis from the shaft, and producing the condition known as "acute epiphysitis."

The usual termination of those cases which do not rapidly prove fatal from general septic infection, is in necrosis of the whole bone, or, more frequently, of the shaft between the epiphyses (Fig. 25). The further history of the disease is then simply that of necrosis of bone.

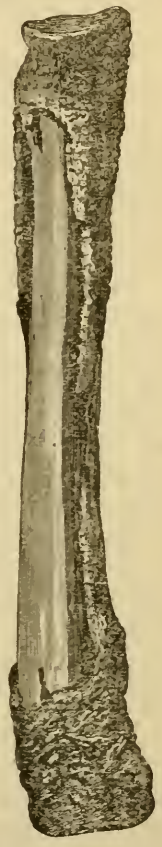

Fig. 25.—Necrosis of the whole shaft of the Tibia between the epiphyses, as a result of acute osteo-myelitis. The dead bone lies loose in a partially formed shell of new periosteal bone. (Museum, Bristol Royal Infirmary.)

The minute anatomy is a compound of cellular proliferation, vascular blocking, diffluence of fatty tissue, and general infiltration with micro-organisms. The bony tissue proper, suddenly cut off from its nutritive supply and rapidly dying, has had no opportunity of exhibiting the signs of inflammation, and is essentially unchanged.

Symptoms.—Almost from the beginning diffuse osteo-myelitis has all the symptoms of a grave disease. Its onset, often marked by a rigor, is signalised by high fever, with profound constitutional disturbance, and frequently delirium. There is severe pain in the part, which radiates in various directions; and considerable tenderness on pressure. Duskiness of the skin, with some diffuse swelling, soon appears, to be rapidly followed by the formation of abscesses. The patient either dies within a few days; or the symptoms merge into those of septicæmia, which, in its turn, proves fatal; or the course

of the disease is diverted into that of an ordinary necrosis. Very rarely, on prompt and judicious treatment, the progress of the disease is cut short, and the patient escapes without either septicæmia or necrosis.

The distinguishing characters of the disease are its rapid onset, and the high fever attended with grave depression, very rapid pulse, and perhaps delirium. Locally the diffuseness of the pain, the duskiness and œdema of the soft tissues, and later on the occurrence of abscesses at central and outlying points, are characteristic features.

Treatment.—Immediately on its being recognised, diffuse osteo-myelitis ought to be treated by the making of one or more free openings into the medullary cavity. The openings are made after free incisions in the soft parts, with gouge or trephine, and must be large enough to permit access to the medulla, and to provide free drainage. It is a question whether the best treatment would not be to remove the whole of the suppurating medullary tissue by scraping, and wash out the cavity with antiseptic fluids. Free incisions are made through the periosteum in several positions, to prevent its being completely stripped should subperiosteal suppuration come on, as it is likely to do.

These measures represent all that can be done to check the ravages of the disease. The case is closely watched, and if symptoms of septicæmia supervene, amputation is the only resource. Done sufficiently early, before the strength of the patient is gone, amputation in this disease has had sufficiently encouraging results. The treatment proper to necrosis of the shaft when this takes place is described under Necrosis.

From the beginning constitutional treatment of a supporting or stimulating nature must be rigorously

enforced. Ammonia, ether, bark and alcoholic stimulants, with concentrated and easily digested nourishment, must be administered in large and frequently repeated doses.

Acute epiphysitis.—This is a form of acute osteo-myelitis, occurring in children near the ends of the long bones, and resulting in disjunction of the epiphysis from the shaft.

Though, pathologically, it probably does not merit the position of a distinct disease, its clinical features are so distinctive and its importance so great that it generally receives separate consideration.

Causation.—Sometimes a blow or other injury is made to account for the disease, but most frequently no such cause can be assigned. It is probably always septic in immediate origin. This septicism may arise from general causes, or locally, from lymphatic infection carried from a sore to the bony marrow. It is found almost exclusively in children or young infants, and usually in such as are in feeble general health.

Pathology.—Its pathology is probably identical with ordinary septic osteo-myelitis. It is peculiar in this, that the inflammation is most active and most destructive where histological activity is greatest, namely, in the parts close to the epiphysial cartilage. Suppurative inflammation in the marrow of this region causes a rapid disintegration of the cartilage, with consequent disjunction of the epiphysis from the shaft. The end of the shaft is surrounded with pus and débris of medullary tissue, which may force its way into the contiguous joint, or through the skin, or in both directions. That the focus of the inflammation is in the active tissue, abutting on the epiphysial cartilage, there need be no dispute; that it starts in the cartilage itself, or in the epiphysis, as is maintained by some surgeons, is exceedingly doubtful.

Symptoms. — As already stated, the disease is found in unhealthy children during the first few months of existence. It is situated most frequently in the femur at the hip joint, and with diminishing frequency at the knee joint, the shoulder, the elbow, and the ankle. Locally it presents the ordinary signs of an acute inflammation rapidly going on to suppuration, and at a very early stage affecting the joint. The child is evidently seriously ill with high fever, and great depression of the vital powers. When the disease has existed for a few days, grating on movement with perhaps undue mobility, marking disjunction of the epiphysis, will probably be found. The disease rapidly progresses, and may be fatal within two or three days. In cases that are not rapidly fatal abscesses form and burst, and recovery may take place after a tedious illness. The bone may become united, though its future growth is stunted. As the joint is implicated at a very early stage of the disease, it is easy to mistake it for a pure joint affection; indeed, it is frequently described among diseases of joints.

Treatment.—To support the child's strength and to provide free exit for the pus are the leading indications for treatment. Early and free incisions, with sufficient drainage and antiseptic dressings, give the best chance of cure. Indeed, with such treatment, it is surprising to find how great the recuperative power sometimes is. The disjoined fragment unites firmly to the shaft, the inflammation in the joint subsides, and the articulation may be left with free movement. If, after such treatment, signs of improvement are not apparent, amputation above the disease is the only resource left.

Necrosis.—By necrosis of bone is understood a death of the whole or some part of the bone without marked alteration in its structure, and following one or other of the varieties of acute inflammation.

Causation.—The immediate cause of necrosis is stoppage of the circulation, either through the vessels being torn by injury, or from their becoming blocked as a result of the inflammatory process. The remote causes are those of the form of inflammation which gave rise to it. An acute form of necrosis is liable to follow any of the specific fevers, especially scarlet fever; scrofula and syphilis predispose to the more chronic forms. Among local causes, injuries, as blows, wounds, or amputations, hold the first place. A peculiar form of necrosis in the lower jaw is found among workers in phosphorus. In old people a variety, analogous to senile gangrene of the soft tissues, and known as senile necrosis, is met with.

Fig. 26.—Tibia showing in its upper third superficial necrosis; in its middle third necrotic caries (not well shown in drawing); and in its lower third total necrosis surrounded by an almost complete involucre of new bone. (Museum, Bristol Royal Infirmary.)

Pathology.—Necrosis has already been mentioned as a possible termination of the three leading varieties of inflammation in bone. Generally speaking the variety of necrosis is determined by the nature of the inflammation. Thus periostitis, as a rule, causes a superficial necrosis of the outer layers of compact

bone (*peripheral necrosis*); osteitis most frequently results in death of a portion of the cancellous or compact tissue (*central necrosis*); while endosteitis, if acute, causes death of the whole shaft (*total necrosis*).

In every case the immediate cause of necrosis is thrombosis in the blood-vessels, induced either by injury or inflammation. The piece of dead bone thus cut off from its vital connections is essentially a foreign body, and acts as an irritant upon the surrounding tissues, causing the formation of an abscess. The suppurative process thus set up, with the concomitant separation and disintegration or extrusion of the bone, along with certain conservative processes in the outlying tissues, constitute the chief features of the disease.

In detail the pathological process is as follows. The outlines of the dead bone are marked off by a limiting area of thrombosis in the living tissue. Behind, up to, and in this thrombotic area, the ordinary process of rarefying osteitis is set up. The inflammation is most active in the immediate proximity of the dead bone, and here the rarefaction soon proceeds to complete absorption, thus setting the dead bone free from the living. The granulations which sprout from the rarefied bone now act upon the dead bone as well, causing its absorption or, rather, disintegration. The gap, gradually increased between the living and the dead and now loosened bone, is occupied by granulation tissue, bony detritus, and pus.

Concomitantly there goes on a conservative development of new bone. This takes place in the periosteum, in the granulation tissue which occupies the medullary canal, and in the rarefied compact bone which lies around. The periosteum in such a case will have been stripped from the bone and elevated by the burrowing pus, so that there is always a little

space between the periosteal new bone and the dead portion. The new growth starts in the periosteum, covering the living bone at some distance from the

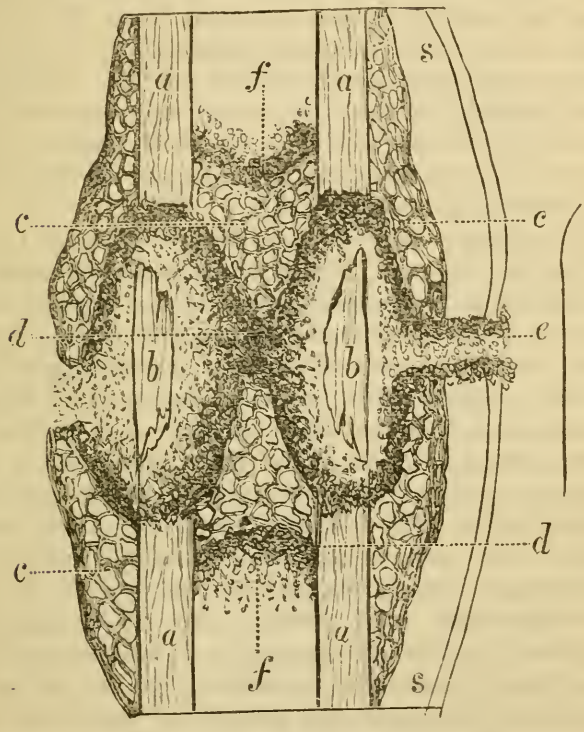

Fig 27.—Diagrammatic Representation of the Process of Necrosis. The drawing is supposed to show a slice cut longitudinally through a long bone which has suffered total necrosis of part of the shaft.

aa, Shaft of healthy bone; *bb*, necrosed portion; *cc*, areolar new bone developed under the periosteum and in the medullary canal; *dd*, granulations sprouting from the new areolar bone surrounding the necrosed portions lining the sinuses (*e*) and marking the limits of the extension of the new bone up the medullary canal (*f*); *s*, skin.

line of necrosis, and in the course of time, with the exception of some openings through which pus is discharged, completely ensheaths the loosened necrosed

bone or sequestrum, as it is called. In the granulation tissue which replaces the medulla in the hollow of the shaft new bone is also developed, which may not only completely plug the opening, but extend along the cavity in the necrosed bone till the ends meet, forming an internal callus which is covered by the dead bone as a sort of ferrule. The new bony growth in the surrounding compact bone, thinned by rarefying osteitis, is of the nature of an osteo-plastic osteitis filling up enlarged cavities rather than increasing general bulk.

The changes may be seen from a study of the accompanying diagram (Fig. 27). It will be noticed that the dead bone lies bathed in pus, in an abscess cavity which is lined by granulations mostly springing from young areolar bone. This pus, containing a large amount of bone salts, reaches the surface through openings called, in the bone, cloacæ ; and, in the soft tissues, sinuses or fistulæ. The dead bone is now known as a *sequestrum*, and the process of separation as *exfoliation*. The abscess cavity may increase or diminish in size round the steadily diminishing sequestrum. As a rule the new bone grows in upon the sequestrum more slowly than the sequestrum diminishes, so that the longer the case has lasted, the more loosely does the sequestrum lie in its cavity. Occasionally, however, the growth of new bone is so exuberant that the sequestrum is embedded in it, and fixed so as to become almost immovable (Fig. 28). Sometimes, again, the cavity around the sequestrum seems to enlarge instead of diminishing.

Symptoms.—The symptoms of necrosis follow an aggravation of the symptoms of the inflammation in periosteum, bone, or medulla which gave rise to it. The pain, fever, and swelling increase till evidences of suppuration appear with formation of an abscess, which bursts through the skin if it is not opened. A

probe introduced through the opening so made strikes upon bare compact bone of normal density. The signs of acute inflammation now subside, and the abscess opening becomes a fistula surrounded by red granulations, and discharging quantities of liquid yellow pus. Most frequently there are two or more such fistulæ. A probe introduced along one or other of these openings strikes on the bare sequestrum, which may or may not be loose, according to the duration of the case.

Necrosis is most liable to be confounded with caries. Necrosis is distinguished most readily by the hardness and smoothness of the bare bone struck by the probe introduced through the fistula; in caries the bone is rough, and so soft that the probe may be pushed through it. In necrosis, the granulations, red and healthy-looking, pout at the openings, and the surrounding skin is of normal colour and consistency; in caries the openings are small, not usually filled with granulations, and the surrounding skin is undermined and reddened. The discharge in necrosis is usually yellow healthy-looking pus; in caries it is watery, pale, and unhealthy. In necrosis there is considerable thickening, rough and unyielding, caused mainly by the periosteal new bony growth; in caries, if there is any thickening, it is caused by œdematous swelling of the soft tissues, or by mere expansion of the bone, and is not usually nodular on the surface.

Treatment. — The indications in treatment are to get rid of the sequestrum, and to support the strength of the patient while the tedious process of suppuration is going on. For the latter, fresh air with out-door existence where possible, and the administration of cod-liver oil and iron with plenty of good food, are the chief requisites. Any constitutional dyscrasia, such as scrofula or syphilis, must be treated by their proper remedies.

Locally, the treatment is simply removal of the sequestrum. If the dead bone is small and superficial, it may escape through the sinus or be simply lifted out of its bed before the encapsuling new bone is developed. But as the new bone closes round the sequestrum, the chances of spontaneous removal diminish, and some operation is usually necessary to take it away (Fig. 28).

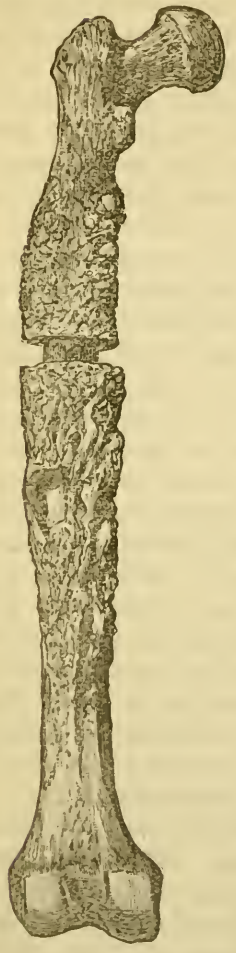

Fig. 28.—Femur affected with total Necrosis of the middle third of its Shaft. The ensheathing new bone is sawn through at the middle to show the sequestrum. Several cloacæ are visible. This femur is from the first case of amputation at the hip joint performed in England in 1814. (Museum, Bristol Royal Infirmary.)

Sequestrotomy, as the operation for removal of a sequestrum has been called, is not usually performed till the dead is freed from the living bone and lying loose in its bed. In some cases of limited and superficial necrosis the sequestrum may be readily removed by forceps with or without a simple skin incision. In most cases, however, a more complicated proceeding, involving division of the new bone, is necessary.

In an ordinary case the operation is as follows: The limb is rendered bloodless by elevation or by Esmarch's

method, and a rubber tourniquet applied. The most convenient sinus is selected, and the underlying cloaca exposed by suitable incision through the soft parts. If the cloaca is large enough to admit of its passage, the sequestrum is seized by a special forceps called necrosis forceps, and removed. If the cloaca is not large enough, it is enlarged by gouge or trephine, and, at the same time, the extraction of the sequestrum may be facilitated by dividing it in the middle by bone forceps and removing it in halves.

The granulations lining the cavity from which the sequestrum has been removed are scraped out, and the whole cavity swabbed or irrigated with a strong antiseptic fluid. If there is bleeding the cavity must be plugged with strips of boracic lint, or of lint sprinkled with iodoform, or some such similar dressing.

If, as frequently happens in cases of total necrosis, the new bone is small in amount and liable to become fractured, a splint must be applied and worn for some weeks. In most cases rest and elevation of the part will be advisable, though it will rarely be necessary to confine the patient to bed.

In cases of extensive necrosis where septic absorption with high fever are rapidly sapping the patient's health, and where an immovable sequestrum with advanced suppuration in the soft parts render mere sequestrotomy an operation not likely to be successful, amputation may be called for. Accidental injury to vessels or other structures by an extended sequestrum may be a reason for amputation.

Quiet necrosis, or necrosis without suppuration, is the name given to a form of necrosis in which the signs of inflammation are slight or absent, and the sequestrum either disappears or is encapsuled without the formation of an abscess which opens externally.

The dead bone is passively tolerated or quietly removed without any external signs. This form of necrosis is very rare.

Phosphorus necrosis of the jaws is a peculiar form of necrosis which attacks the jaws of workers in phosphorus. The immediate cause is supposed to be the action of phosphorous acid on bone that abuts on carious teeth. An osteitis is thus set up which spreads outwards under the periosteum, and, becoming suppurative, elevates that tissue from the bone, thus causing its death. In this, as in other forms of necrosis of the jaws, there is always an excessive development of new bone around the sequestrum, rendering the process of cure tedious and difficult.

Care in seeing to the cleansing of the teeth, and the use of the red amorphous phosphorus instead of the yellow variety, have been found to diminish the susceptibility to the disease.

Diseases of Nutrition.

A small and comparatively unimportant class of diseases of bone, depending neither on actual inflammation nor on specific constitutional dyscrasia, are described as diseases of nutrition. They may be subdivided into *hypertrophic* and *atrophic* varieties.

Diseases of Nutrition attended with Hypertrophy.

Simple hypertrophy of bone.—Most cases of enlargement of bone originate in inflammation from injury. Examples of simple overgrowth are best seen in cases where the ordinary pressure to which a long bone is exposed has been removed. The general increase in length which frequently occurs when a young person is confined to bed for a time is an example of this sort. Another example may be seen in the increase of length which a radius,

dislocated at its upper extremity and unreduced, may undergo. In the rare cases of simple overgrowth of one or more fingers or toes, or even of a whole limb, the bone simply participates in the general hypertrophy. It is doubtful if the enlargement which follows rickets is to be regarded as simple hypertrophy.

Osteitis deformans (Paget).—This is a rare and extraordinary affection of the bones, probably inflammatory, attended with increase of bulk and frequently with distortion of shape. It occurs specially in persons after the prime of life, is accompanied with considerable pain, and usually attacks several bones simultaneously or in succession. No specific cachexia has been found associated with the disease, and, though it may last over a number of years, it may produce little or no impairment of health. Locally the bone is enlarged in all its dimensions, rarefied in its compact portions, and thickened and roughened under the periosteum. The clinical features are elongation of the limbs from the bony overgrowth, and distortion in the shape of the spine, pelvis, skull and thorax, as well as of the limbs, from the weakness caused by rarefaction.

No treatment has been found of benefit. The disease, after continuing for years, may become spontaneously arrested, leaving the bones increased in bulk and in density. In a few cases malignant growths have appeared in the hypertrophied bones.

Leontiasis ossea (Virchow).—This is a curious disease limited to the bones of the skull and face, and marked by an increase in their thickness, so great that the patient is usually killed by compression of the brain or blocking of the nose and pharynx. The condition seems to be an enormous overgrowth, with increased sponginess of the diplöe. It always commences in early life. Billroth speaks of a similar

affection found in the flat bones generally, and likens it to elephantiasis of the skin. The cause is unknown, and all treatment has been ineffectual.

Diseases of Nutrition attended with Atrophy.

Simple atrophy.—Any diminution of nutritive supply may be followed by simple atrophy of bone. In old age thinning of the compact bone and rarefaction of the cancellous portions takes place in the bones generally, rendering them liable in favourable localities, such as the neck of the femur, to fracture from slight causes. Interference with the blood supply, as in cases of fracture where the medullary artery is torn through; destructive inflammation of the epiphysial cartilage in young growing bones; diminution of function, as in anchylosis of the elbow, and all such influences, are followed by bony wasting.

Fatty atrophy.—In all cases of atrophy of bone yellow marrow more or less completely replaces red marrow. In health, where there is no cancellous tissue, as in the centre of a developed long bone, the marrow is almost pure fat. It is the same in disease; as the cancellous bone disappears the marrow in its meshes becomes fatty. This condition is specially seen in the long bones around joints that have been long inflamed and out of use. In such cases the red marrow may have completely disappeared, its place being taken by a tissue that is little more than fat; the compact bone is reduced to a mere shell, and the cancellous bone is a delicate and friable tissue that can be cut with the knife and crushed between the fingers. The condition is seen in its most typical form in the bones of the thigh and leg after long-standing strumous disease of the knee joint.

Fragilitas ossium.—Though this term is applicable to several conditions associated with diminished strength of bone causing a tendency to fracture on

slight provocation, it has also a special significance as applied to children. A child may occasionally be found who has suffered fracture of almost every bone in the limbs and not a few of the body before it has reached the tenth year. Running on a stone pavement, playing leap-frog, striking a smart blow, have been known to cause fracture in such cases. Some of the bones may have been broken several times in succession, uniting in the ordinary way and with average rapidity. No cause has been discovered beyond an excessive tenuity, with perhaps increase of density in the bony tissues. The children are usually fragile, but not diseased.

A brittleness of bones may be caused by various diseases, such as aneurism of bone, new growths, necrosis, osteo-malacia, and atrophy.

Constitutional Diseases of Bone.

Under this heading are described a number of affections of bone which are associated with definite and palpable constitutional disease, and which may appear in any or every bone of the body. They are scrofula, with its ally tubercle, syphilis and osteo-malacia.

Scrofula and tubercle in bone.—The relations of scrofula to tubercle cannot here be discussed. The want of definiteness which for years has attached to the meaning of these terms is seen, perhaps, at its worst in diseases of bones. At present the tendency is to consider them pathologically identical, giving them the same causation (the bacillus tuberculosis), and combining the wide clinical divergencies in the assumption that they are different stages in the same affection. (*See* Arts. on Scrofula and Disease of Joints.)

From a purely clinical point of view we can distinguish at least three forms of disease of bone, scrofulous or tubercular, as we may prefer to name them which may be described under this head. These

are the miliary tubercle; the mass of degenerate cheesy material often described as caseating tubercle; and that form of low rarefying osteitis usually described as scrofulous caries.

The miliary tubercle or nodule occurs in the marrow lying in cancellous bone, either as a part of general miliary tuberculosis or as started by local infection from a mass of caseating inflammatory material. As met with here, its structure and behaviour are the same as elsewhere. As a part of general miliary tuberculosis it is a fatal disease; as originating in infection from caseous products it may be either the forerunner of general tuberculosis or the indication of advancing and grave local disease in the bone.

The mass of degenerate imflammatory material, known as caseating tubercle, is also chiefly met with in the cancellous ends of the long bones. In structure and behaviour, as well, in all probability, as in pathological origin, such masses are closely allied to those met with in scrofulous lymphatic glands. They may exist for prolonged periods, producing but few symptoms, and any change that they undergo is likely to be further retrogressive. The importance of such collections is enhanced from their proximity to joints, and their tendency to implicate these in their degenerate changes. Such masses contain in their substance little or no bony tissue. The osteitis which preceded it will have greatly thinned, or completely destroyed the cancellated trabeculæ.

The best known and by far the most important form of scrofulous bone disease is the variety of caries to which it gives its name. Indeed, most examples of caries own scrofula as a predisposing cause. None of the bones are free from it, though it has decided predilections for certain sites. It is found most frequently in the bones of the hands and feet, in the

bodies of the vertebræ, and in the cancellous ends of the long bones. As caries of the carpus and the tarsus among the young of the poorer classes, it is, perhaps, the most common of all diseases of bone, running a very slow course, attacking one bone after the other, rarely capable of cure, and ultimately demanding amputation. As "strumous dactylitis" in children, it attacks the long bones of the hands and feet, expanding the compact shell, and transforming the medullary contents into fungating granulation material. Attacking the bodies of the vertebræ, it is well known as Pott's disease, or angular curvature of the spine. In the ends of the long bones it has a special importance, as being a frequent cause of one of the most intractable forms of chronic joint disease.

In these instances the affection lies in the medullary cavity. Sometimes, however, it appears under the periosteum as a "strumous node," producing an abscess and superficial caries.

Symptoms. — The symptoms of simple miliary tubercle in bone are those of general miliary tuberculosis. A number of miliary nodules around a caseating focus produce no symptoms beyond its cause. A mass of tubercular caseated material usually produces slight or no symptoms till it breaks up and suppurates, when the symptoms are simply those of scrofulous caries.

In scrofulous caries the onset is uncertain and the progress slow. Otherwise, the symptoms are simply those of ordinary caries, already described, *plus* the signs of the scrofulous diathesis. In strumous dactylitis the disease is somewhat peculiar in causing expansions of the bony shell, forming a chronic abscess within the bone, which, even after an exit for its contents has been provided, may continue to discharge indefinitely. Elsewhere perforation of the compact bone usually takes place before expansion is perceptible.

Treatment. — Constitutionally the scrofulous element is treated by the ordinary remedies. Locally, before suppuration has commenced, counter-irritation by blisters or the actual cautery, the application of Scott's dressing, or the oleate of mercury, with elastic compression by rubber bandage, have been of benefit. Most frequently, however, suppuration takes place, and our efforts are then directed to the removal of the fungating granulations with the carious bone after the manner above described. In disease of the tarsus or carpus, excision or amputation is usually necessary. In strumous dactylitis amputation is usually performed; but if a good portion of the expanded bony shell is removed, with the attached skin, and the cavity dressed from the bottom by some stimulating antiseptic material, cure may be got without amputation. In every case, before perforation has taken place, Listerism in all its details will be attended with the best results.

Syphilitic diseases of bone. — Syphilitic diseases of bone may be considered under two heads, as they originate (1) from acquired syphilis, or (2) from congenital syphilis. (*See* Art. on Syphilis.)

Osseous lesions in acquired syphilis.— These occur as periosteal inflammations, frequently resulting in caries and necrosis, and as chronic osteitis producing general thickening. They are recognised as tertiary manifestations.

Pathology. — Syphilitic bony disease is most frequently met with as localised collections of small-celled inflammatory material between the periosteum and compact bone. Such collections may be regarded as gummatous tumours. They elevate the periosteum, forming hard, rounded elevations, and are known as *periosteal nodes.* Under appropriate treatment these nodes may disappear, but frequently they go on increasing in size; the lowly organised inflammatory

material breaks down and suppurates, forming a gummatous ulcer with sluggish granulations, which extend some way into the bone, rarefying and disintegrating it. This is *syphilitic caries.* In bones which depend mainly upon the periosteum for their blood supply, as the flat bones of the skull or face, such elevation of the periosteum by gummatous material may kill the bone by deprivation of nourishment, and the result is *syphilitic necrosis.* The least common form of syphilitic bony disease is where there is a general low form of diffuse inflammation, resulting in a hypertrophic thickening of the mass. This is known as *syphilitic osteitis* or *sclerosis.*

Symptoms.—In addition to the ordinary history of syphilitic infection, certain local peculiarities suggest the specific origin of these complaints. The periostitic node is found most frequently on the tibia, the ulna, and the clavicle, and appears under the skin as a hard, rounded, and tender swelling. Pain is almost uniformly worst at night. If the swelling increases much in size and is about to suppurate, it extends chiefly at the margins, leaving a soft, often depressed, area in the centre covered with purple congested skin. When the skin breaks, the unhealthy granulations lie in a bed of carious bone, which is diagnosed in the ordinary way. On the skull, and especially on the forehead, syphilitic bony disease manifests itself usually as small areas of necrosis, leaving, when the dead bone is removed, similar punched-out ulcers, which extend through the outer table, and frequently the inner table as well. In the neighbourhood of such ulcers that have been of any duration, there is usually some considerable amount of bony thickening. The middle line of the hard palate is frequently affected, causing the formation of an opening between the nasal and oral cavities. The nasal bones and parts of the jaws are also often

involved. Nodes may grow inwards on the brain, producing cerebral symptoms. In syphilitic sclerosis, which by preference affects the long bones, shifting pains, with diffuse thickening, are the only local signs.

In suppurative syphilitic bone disease the discharges are usually fœtid and the wounds foul and unhealthy. In necrosis of the bones of the face the fœtor is met with at its worst.

Treatment.—The treatment proper to the constitutional disease is to be fully and systematically carried out. Till the constitutional treatment has had a fair trial, no operative treatment is to be instituted. Not only nodes, but even collections of semipurulent material may melt away under the administration of iodide of potassium or mercury, or both combined or alternated. If an abscess must be evacuated, it must be done through as small an opening as possible, as there is a tendency for large sluggish sores to follow injury to the skin. Local measures for the removal of carious or necrosed bone need not be carried out with so much energy in syphilitic as in strumous disease. For the dressing of the open sores nothing is better than iodoform. Surgical cleanliness in its most perfect form must be minutely observed.

Osseous lesions in congenital syphilis.—These are met with chiefly in two forms: (1) as atrophic changes in the bones generally, and in special situations; (2) as hypertrophic growths (nodes or osteophytes) in various situations, but more especially in the skull.

Atrophic changes in congenital syphilis are found most frequently in the bones of the skull, in the long bones, and in the teeth.

In the skull the disease shows itself in very young children as a wasting of the bones at the sites of decubitus, that is to say, behind the eminence of the

parietal bone, in the occipital bone, and in the squamous portion of the temporal. The bone is either much thinned, so as to become like parchment, or is transformed into a gelatinous material, in which no bony tissue can be felt. This condition is known as *cranio-tabes.* (*See* Art. on Syphilis.)

In the long bones the changes appear usually in the neighbourhood of the epiphysial cartilage, and consist mainly in an excessive deposit of lime salts in the cartilaginous matrix, along with an overgrowth of the young medullary tissue, which absorbs and replaces the bone. The bone is thus made at once brittle and soft, liable to bend in bulk or to break in portions. It sometimes results in suppuration. When the disease is at its height the infant will not move the limb : it seems to hang paralysed and inert, and this appearance, with the wasting of muscle that always supervenes, has given to the condition the name of *syphilitic pseudo-paralysis.*

In the teeth the condition is that first described by and named after Mr. Jonathan Hutchinson. It is a pegging and notching of the permanent upper central incisors. The teeth are too small for the spaces they have to fill ; they tend to become pointed, then cutting edges are hollowed out and crescentic, or notched and tuberculated. The lateral incisors are sometimes pegged also, and the canines are often too pointed. The cause is probably an old stomatitis interfering with the development of the tooth bulbs. (*See* Art. on Syphilis.)

Hypertrophic changes in congenital syphilis are met with as localised subperiosteal developments of porous bone in the bones of the skull and in some of the long bones.

In the skull they are known as *Parrot's nodes* or *osteophytes.* They appear as broad flattened bosses, usually four in number, upon the four bones that surround the

anterior fontanelle, but are found also skirting the sagittal and coronal sutures. They are composed of spongy vascular bone with wide spaces. Such growths may attain to considerable thickness, as much as half an inch; and they may extend laterally so as to cause premature closure of the sutures. They very rarely break down and suppurate. They nearly always appear between the sixth and the twelfth months.

In the long bones such nodes are usually found on the tibia or the humerus, appearing at about the same age and following the same course. Their site is near the epiphyses, and most frequently in the neighbourhood of the knee and elbow joints.

The treatment of the osseous lesions of congenital syphilis is simply that of the constitutional disease. Local measures are not called for.

Mollities ossium; osteo-malacia; mala-costeon. – This is a constitutional disease characterised by a general softening of the osseous tissue, rendering it liable to be bent or broken.

Causation. — Almost nothing is known of the origin of this rare and extraordinary disease. In some few cases it is inherited. It is twelve times more frequent in females than in males, and among females more than two-thirds of the cases appear during the child-bearing period. Most usually it occurs during and after adult life; but it has been met with at, and even before, puberty. Theories as to its being caused by a dissolving action of carbonic acid or lactic acid want confirmation.

Pathology.—The essential features of the disease are, replacement of the medullary tissue by a dark-red grumous semifluid material, and rarefaction and absorption of bone. The disease advances centrifugally, beginning usually in the yellow marrow, and extending upwards and downwards into the red marrow in the cancellous bone, and outwards into the

compact tissue. Rarely, however, does it attack the subperiosteal outer lamellæ; in the most advanced cases, where the greater part of the bone may have completely disappeared, there nearly always remains a thin shell of comparatively healthy material which maintains the shape of the original bone. Into the substance of this pulpy, vascular material hæmorrhages frequently take place, and small cystic cavities with fluid contents and well-defined walls are often formed.

The salts are dissolved out as if by an acid, leaving a layer or zone of animal substance, which in its turn is broken up and diffused in the new growth.

Symptoms. — In the early stages the symptoms will be little more than obscure, shifting pains in the bone often described as rheumatic. No other sign of disease beyond, perhaps, general malaise and emaciation, may appear, till a spontaneous fracture or bending of bone takes place. An examination of the urine, revealing the presence of an excess of phosphates with lactic acid, will now suggest a diagnosis, which will probably soon be confirmed by the occurrence of other fractures and distortions. On the slightest provocations any of the long bones may bend or break, and the chest, pelvis, and spine may be distorted by the normal pressure they have to bear. In the pelvis the deformity, consisting of a diminution of the oblique diameters from pressure inwards by the heads of the femora, is a frequent cause of difficult parturition, occasionally necessitating operative interference. The softened ribs may permit the chest to collapse, and the patient may die from physical inability to breathe. In the worst cases the most extraordinary appearances may be produced from the exaggerated distortions.

A few cases recover; some live to a good old age while the disease continues; most, however, are fatal.

Treatment. — No treatment specially aimed at

the pathological condition has been found of the slightest avail. Treating symptoms we may give tonics and plenty of nourishment to maintain the strength, with opium to relieve pain; while to prevent fractures and avoid distortion we may enjoin rest in the recumbent position.

TUMOURS OF BONE.

Primary malignant growths; sarcoma.—Recent investigations seem to show that all primary malignant tumours of bone belong to one or other of the varieties of sarcoma. Scirrhus, encephaloid, and epithelioma invade bone almost never except as secondary growths.

Sarcomatous tumours in bone are of the ordinary varieties, *i.e.* round-celled, spindle-celled, mixed, and myeloid. Bone is frequently developed in their substance (osteoid sarcoma), but ossification is not confined to any one variety of growth. The best clinical classification is into *central* and *peripheral* sarcomata, that is growths arising in the medulla in the centre of the bone, and growths arising under the periosteum.

Central sarcoma of bone arises usually in the cancellous tissue at the end of the shaft. As it grows it pushes the compact bone in front, expanding and thinning it. It extends along the medullary cavity in both directions, but rarely passes the articular cartilage to enter the joint. The thinned outer shell may be perforated at various points, and the overlying soft tissues are then invaded. In this state spontaneous fracture is liable to take place. All forms of sarcoma are met with in the centre of bones. Central sarcomata ossify less frequently than peripheral. They may attain to enormous dimensions, and are peculiarly liable to recur in internal organs

after removal. Like sarcomata elsewhere, they rarely invade the lymphatics (Fig. 29).

Peripheral or subperiosteal sarcoma of bone arises, as its name implies, between the periosteum and the bone. It burrows between these tissues, invading the bone from the outside. Here also all varieties of sarcoma are met with. Ossification is more common in peripheral than in central sarcoma. In the substance of periosteal sarcoma there is frequently developed a variety of osteophyte, composed of spicules, or closely-set lamellæ, or hollow tubes, which are probably developed around the periosteal vessels, as they are dragged out of the underlying bone by the growing tumours. Occasionally a thrill or bruit may be detected in the growth.

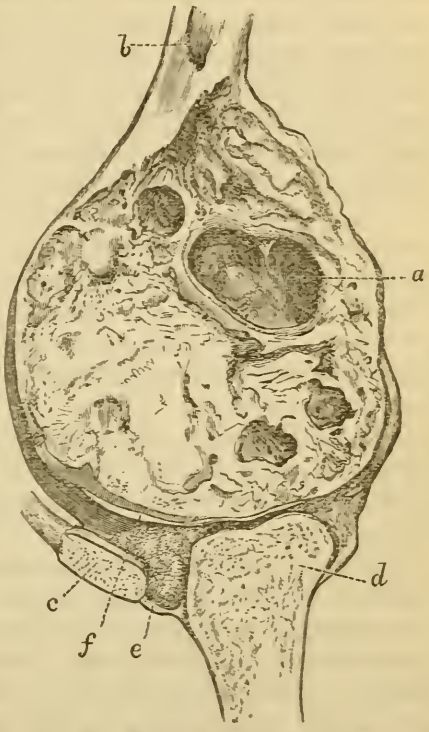

Fig. 29.—Myeloid Sarcoma of Femur.

a, Cyst; *b*, femur; *c*, patella; *d*, tibia; *e*, fat; *f*, cartilage. (From Pepper's "Surgical Pathology.")

Symptoms and diagnosis.—The early symptoms of central sarcoma are very similar to those of deep osteitis, namely, deep-seated pain of a gnawing or bursting character, with some tenderness. When

swelling comes on, the rapidity of its increase with absence of redness of the skin, or other signs of inflammation, point to sarcoma. When the growth has attained to considerable dimensions, and the outer shell of bone is much thinned, manipulation may produce a peculiar sensation of crackling. The skin stretched over the swelling is white and glossy, with blue veins coursing under it. Where the growth has escaped from its bony shell, the soft, boggy, semifluctuating nature of the tumour may be detected. Occasionally there is a bruit or even visible pulsation.

In periosteal sarcoma there is less pain. The growth feels soft and boggy from the beginning, and in the early stages may even be mistaken for abscess. By deep pressure an overlapping margin of tumour substance may be felt, and this, with its firm connection with the underlying bone, will help to distinguish it.

In both central and peripheral sarcoma, a history of injury is curiously frequent, so frequent, indeed, that traumatism must be considered as predisposing, if not causal.

It is possible to mistake sarcoma in the neighbourhood of a joint for strumous disease. In those cases where cartilage is found in a sarcomatous growth, it is sometimes impossible to diagnose it from enchondroma. Generally speaking, enchondroma is harder, and more tubercular on the surface, while it increases in size less rapidly. Clinically, it is usually impossible to distinguish the histological varieties of sarcoma.

Treatment. — The only treatment for sarcoma in bone is to remove it. Such removal must nearly always involve amputation of the limb. In periosteal sarcoma it may be possible to remove the growth, and as much of the bone as may be implicated, but very rarely is it wise to be content with this. In endosteal

growths amputation must always be performed. If the growth is small and circumscribed, it may be possible, by amputating through the bone above the growth, to remove the whole of the disease. But in most cases it will be wise to amputate through the joint above the disease. The disease extends along the medulla with such rapidity that only in the early stages is it likely to be unaffected, and thus the greatest security against recurrence is got by disarticulating the bone. When the intermuscular fasciæ are affected, amputation through the joint is still more necessary.

Myeloid sarcoma is supposed to give the best results after amputation through the bone; spindle-celled sarcoma ought always to be treated by disarticulation. In either case secondary recurrence, especially in the internal organs, and particularly in the lungs, takes place in many instances after operation.

Secondary malignant growths in bone.—All secondary malignant diseases in bone are endosteal, unless they are direct extensions from contiguous growths, when they may be periosteal.

Sarcoma in any situation may produce secondary disease in bone by infection from a distance. Carcinoma in bone is practically always secondary, most frequently it is metastatic, though in certain situations, as in the ribs from cancer of the breast, it is not uncommon as a direct extension of the disease. Encephaloid, as secondary to disease of the liver, is not uncommonly found in bone. Epithelioma of bone is rare; it always originates by direct invasion from the soft tissues.

Osteo-aneurism; pulsating growths of bone.—Midway between the benign and the malignant tumours of bone is the class clinically known as pulsating. Of such there are at least three distinct varieties.

1. The most common pulsating growths are soft sarcomata, in which, from the great number of large vessels, or from dilatations in their walls, a general distension of the mass takes place at each beat of the heart. Vascular thrills, or even perceptible pulsations, are not infrequently met with in ordinary myeloid or spindle-celled sarcomata; the variety under consideration is merely one in which pulsation is an abnormally prominent feature.

2. As a second variety are classed certain vascular erectile tumours, composed of numerous interlacing small vessels, similar to ordinary nævus of the soft tissues. Such are usually found on the skull, forming soft reddish elevations, which pulsate under the skin.

3. True aneurism of bone, though in many cases it has been confused with pulsating sarcoma, is now generally admitted to exist. It is simply a cavity in the interior of bone, containing blood, partly fluid and partly clotted, which visibly pulsates. It is in fact an ordinary aneurism, which happens to be located in the interior of a bone.

Symptoms and diagnosis.—A growth in the substance of a bone, which distends it, which pulsates, and which perhaps emits a bruit, may be sarcoma, or true aneurism. If the pulsation is distinctly expansile, and the vascular thrill very palpable, and the bruit is loud and well marked, we may suspect true osteo-aneurism, though we can seldom be certain. Compression of the main artery checks the pulsation; if it is a vascular erectile tumour it visibly diminishes in size; if a pulsating sarcoma, it simply becomes less tense; if a true osteo-aneurism, there is no diminution in bulk, but relief of tension will render palpable certain openings in the expanded bony shell. The last is exceedingly rare, and unless the signs are very definite indeed, we must conclude that the disease is

a pulsating sarcoma. An accurate diagnosis is usually impossible.

Treatment. — Deligation of the main artery of the limb having in most cases been performed for pulsating sarcoma cannot claim many successes.

A few cases of cure by ligation for simple osteo-aneurism have been recorded. In vascular erectile tumours of the scalp, or scapula, or other flat bones, ligation of the arteries entering them may produce cure. In pulsating sarcoma, amputation, on the lines laid down for ordinary sarcoma, is the only resource.

Non-malignant growths.—These are either localised over-growths of the tissues that normally enter into the formation of osseous tissue (cartilage, fibrous tissue, or true bone); or they are cystic developments, simple or parasitic.

Osteoma; exostosis.—With very few exceptions, all bony tumours grow outwards; the few that grow inwards are probably inflammatory. Practically, therefore, all osteomata are exostoses; enostoses may be ignored. They are of three sorts:

The *ivory osteoma, or exostosis*, is usually found on the surface of the skull, frequently on its cerebral aspect, as a smooth, hard, rounded growth, composed of exceedingly dense bone of a consistence resembling that of ivory. Most probably it is a true periosteal growth. The bone is arranged in parallel laminæ; the bone corpuscles are small and have long, slender processes; and the blood-vessels are small and sparsely distributed. As it gets older the bone increases in density, sometimes to such an extent that its vascular supply is cut off, causing a quiet necrosis and separation, as in the stag's horn.

The *spongy osteoma, or exostosis*, is found arising either from the neighbourhood of the epiphysis of a long bone, or from the fibro-cartilaginous insertion of some large mass of muscle. It is developed in

cartilage, and is areolar or spongy, and not laminated, except on the surface. Usually it appears before puberty, and it may go on growing for an indefinite period. Its structure is that of ordinary cancellous bone. A layer of cartilage usually overlies the spongy osteoma, and in it may be found the microscopic appearances of ordinary intracartilaginous development of bone (Fig. 30).

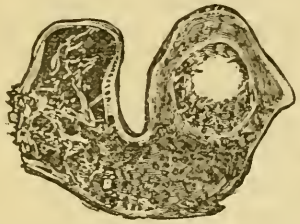

Fig. 30.—Transverse Section of a Simple Cancellous Exostosis, originating in the Linea Aspera of the Femur. There is no change in the structure of the Femur. (Museum, Bristol Royal Infirmary.)

Hereditary multiple osteomata occur in children, and may affect most of the bones of the body. As the name implies, the disease is usually inherited. The tumours appear as hard, nodulated growths, situated mostly near the ends of the long bones, though they are found on other situations. They may be very numerous, and may go on increasing in number and in size for years, causing no harm, except through interference with movement of the joints. They are covered with cartilage, and are of the nature of spongy exostoses. The disease is very rare.

Symptoms and diagnosis. — Unless it interferes with neighbouring tissues or organs, the signs of osteoma are purely physical. A hard, rounded, or irregular tumour firmly attached to bone, painless, and non-inflammatory, and with a history of very slow growth, are its leading characteristics. The situation of the ivory osteoma on the skull, its smooth rounded surface and small size, are diagnostic. The most common situation of the spongy osteoma is on the linea aspera of the femur (Fig. 30); it is found

also on the supracondyloid ridges of the humerus, and on the inner side may be confounded with a supracondyloid process. It is found also under the nail of the great toe (ungual exostosis), elevating the nail and causing much pain and inconvenience by pressure from boots.

Exostosis is most readily confounded with enchondroma of bone, and particularly with ossifying enchondroma. The latter grows more rapidly, and is more irregular on the surface than the former.

Treatment.—Unless it disturbs the function of neighbouring organs or produces some conspicuous deformity, an osteoma need not be interfered with. Situated close to important structures, as in the orbit, or on the inside of the skull, or near a joint, its removal is attended with some difficulty and risk. The growth is taken away by means of saw, chisel, gouge, or bone forceps. It has been found that unless removal is complete and thorough, recurrence sometimes takes place.

Enchondroma.—This is the most common of innocent tumours of bone. It is met with most frequently near the extremities of the long bones, and no doubt originates in many cases from the epiphysial cartilage. It is found either as a diffuse growth infiltrating the whole bony structure, or as a circumscribed outgrowth from the compact shell. The former is most common in the larger bones, the latter, often multiple, in the long bones of the hands and feet. Centres of ossification, or, more accurately, of calcification, are met with most frequently in the circumscribed enchondroma, and sometimes these are so thickly set as to constitute calcification of the whole mass. All the ordinary pathological changes found in enchondroma generally are met with in enchondroma of bone. The tumours are usually slow in growth, but sometimes they increase with

great rapidity, and may attain to enormous dimensions.

Symptoms and diagnosis. — A painless or but slightly painful hard or semielastic tumour of slow growth, attached to bone, nodulated on the surface, not invading the skin, and presenting none of the characters of malignancy, is probably an enchondroma. A thin shell of periosteal bone sometimes surrounds it, when characteristic crackling on manipulation may be detected. If small and calcified it may be indistinguishable from a pure osteoma, though the irregular bosses on its surface are usually distinctive.

Treatment.— In the circumscribed variety, complete removal of the growth, with gouging of the bony surface from which it springs, will probably effect a cure. If the growth is central, extending up the medullary canal, the limb must be amputated above the disease. Generally speaking, removal of the growth will cure in enchondroma of the bones of the hands and feet; in enchondroma of the long bones amputation of the limb will be called for.

Fibrous and fibro-cystic growths. — As originating from the gums (epulis) or from the periosteum covering the bones in the nasal cavities (fibrous polypus), fibrous tumours of bone, or rather of periosteum, are not uncommon. Elsewhere they are almost unknown. Instances of fibro-cystic growths, mostly in the femur, have been recorded, but they are so rare as to be clinical curiosities.

Cysts in bone.—With the exception of dentigerous cysts, simple cysts in bone are extremely rare. Most of those described as sanguineous cysts were probably sarcomata. Hydatid cysts may be found in bone as in every other tissue, but their occurrence, particularly in England, is very uncommon.

III. INJURIES OF JOINTS.

T. Pickering Pick.

Contusions. — Joints are often *contused* by direct violence, such as falls, blows, or kicks. The injury ought always, but especially in the young and delicate, to be regarded as of a serious nature; for with very slight external evidence of injury a very considerable amount of mischief may be set up, or consecutive inflammation of the structures entering into the formation of the joint may follow and involve the integrity of the articulation. Thus, in delicate children, a contusion of the hip, from a fall on the trochanter, may be the starting point of hip joint disease, which may run its course to complete destruction of the articulation.

In some cases there is little to mark the injury beyond the history of the accident and pain, increased on moving the joint; in other cases, rapid swelling of the articulation follows, indicating the effusion of blood, mixed with synovia, into the cavity of the joint. In these latter the blood and fluid, under the influence of appropriate treatment, is slowly absorbed, generally without leading to any permanent inconvenience.

Treatment.—The essence of the treatment consists in perfect rest and the maintenance of complete immobility of the joint by the application of a splint; and there is good reason to believe that in the majority of cases, if this treatment were thoroughly carried out, no untoward results would ensue. The limb should be raised, and cold, by means of evaporating lotions, Leiter's tubes, or an ice bag assiduously

applied. If the joint is so much distended with fluid as to cause tension and severe pain, it may be relieved by means of the aspirator.

Sprains.—By the term "*sprain*" we mean a violent twisting or wrenching of a joint, whereby its ligamentous and tendinous structures are stretched or torn, but in which there is no separation or displacement of the bony surfaces from each other.

The amount of lesion which takes place varies very much in different cases, from a slight tearing of a few ligamentous fibres to a complete laceration or detachment of one or more of the ligaments of the joint, with perhaps displacement of tendons from their sheaths, laceration of muscles or tendons, and considerable extravasation of blood. In some cases small scales of bone, to which the ligaments are attached, may be torn away, constituting the "sprain fractures" described by the late Mr. Callender. The lesions, therefore, of a severe sprain closely resemble, and differ only in degree from, those of fracture, with which they are very liable to be mistaken.

Symptoms.—The immediate effect of a sprain is very severe pain, often of a sickening character. This is rapidly followed by a swelling, partly due to extravasation of blood into the surrounding tissues, and partly to effusion taking place into the cavity of the joint, as the result of inflammation which has been set up by the injury. After a short time, discoloration, extending for some distance above and below the joint, makes its appearance. There is, of course, inability to bear any weight on the limb, and any attempt to move the joint surfaces on each other is attended by increased pain. The degree and extent of these symptoms depend upon the amount of injury which has been sustained.

The remote effects of this lesion are often permanent pain and weakness; or stiffness and even

anchylosis. The former of these conditions may arise from imperfect repair of the torn structures, or from non-absorption of the effused fluid; the latter from chronic inflammation causing adhesions within the joint, or in the sheaths of the neighbouring tendons. In some constitutional conditions, as the rheumatic or scrofulous, the subsequent inflammation may assume the characteristic type of these conditions, and may be very persistent.

Treatment. — The treatment of sprains requires as much care and attention as the treatment of many graver injuries, and perhaps even a greater amount of judgment on the part of the surgeon; for whereas rest is absolutely necessary for the repair of the lacerated tissues, too protracted rest is often mischievous, stiffening the joint and delaying recovery, so that it often requires great discrimination on the part of the surgeon to know how long to continue to keep the joint at rest and when to commence passive motion. Immediately after the receipt of the injury the limb should be laid on a pillow in the position most comfortable to the patient, or, what is perhaps better, loosely connected to a splint, taking care to leave the injured part exposed. This plan secures perfect immobility of the joint, and at the same time prevents stretching of the damaged tissues by supporting the limb. Cold assiduously applied, with a view to subdue inflammation and prevent further effusion, will generally be found most agreeable to the patient. This may best be done by irrigation with spirits and water, which is to be preferred to the application of a bag of pounded ice, or Leiter's tubes, the weight of which is generally a source of annoyance and discomfort. Sometimes warm applications, such as hot Goulard water with laudanum, or poppy fomentations, are more grateful to the patient, and may be then applied. As soon as the

patient can bear it, equable pressure must be resorted to and will be found to be a most potent means of promoting absorption of the effused fluids. This can be done by means of a bandage wetted in lead lotion and carefully applied, the bandage being kept constantly damp with the lotion; or strapping may be used. This treatment must not, however, be continued too long, but as soon as the patient can bear passive motion without pain or renewed inflammation, systematic shampooing and movement of the joint must be resorted to, with friction, and the patient must be encouraged to use the limb as much as possible without causing himself pain.

Wounds of joints.—These are always serious accidents, the severity depending partly upon the nature of the wound and the size of the articulation, but also, to a considerable extent, upon the age and general constitutional condition of the patient. The wound may be incised, punctured, or lacerated; but the severity of the symptoms does not depend so much upon the extent or nature of the local mischief, as upon the fact that putrescible matter collects in the cavity of the joint and undergoes decomposition, setting up a serious train of symptoms and leading to complete destruction of the articulation. Medium-sized wounds are often, therefore, the most dangerous, especially if the edges are contused and lacerated, so that they cannot unite by adhesive inflammation and at the same time are not large enough to permit of the thorough drainage from the cavity of the effused fluids.

If the wound into the joint is large, so that the articular surfaces are exposed, the nature of the injury is at once evident; but if the wound is small, and particularly if it belongs to the class of punctured wounds, some doubt may arise as to whether the joint has been opened or not. This

will generally be solved by the escape of synovia, which will be at once recognised by its oily glutinous character. In some cases, however, this fluid does not exude; but under no circumstances is it admissible to introduce a probe to clear up any doubt in the surgeon's mind, for it may have the effect of completing the perforation into the articular cavity, and thus inducing the very mischief which is to be dreaded. The standard rule in every case of wound in the neighbourhood of a joint, running in the direction of the articulation, ought to be to treat the case as *one of wound of the joint*, until the subsequent progress of the case proves that no perforation has taken place, or that, if it has, the wound has rapidly healed, without setting up a serious amount of inflammation.

Pathology.—When a joint is wounded it rapidly becomes filled with an accumulation of blood, followed almost immediately by synovial fluid, mixed with serum derived from the vessels of the synovial membrane and the clotted blood in the sac. Thus the joint is distended with a highly putrescible matter, to which air is admitted through the wound. It therefore rapidly undergoes decomposition, and becomes converted into a septic material, which results in an acute inflammation of all the tissues of the joint.

There are certain cases where this may not occur, even though no special treatment is adopted to prevent it. If, for instance, the wound is small, and is inflicted with a clean instrument, and if the edges are brought into immediate apposition, union by adhesive inflammation may take place; no air is admitted to the joint, and no decomposition of the effused fluids ensues. Thus, we find that a surgical wound may be made into a joint, as, for instance, for the removal of a loose cartilage, without any destructive changes taking place in the joint. Again, on the other hand,

if the wound is large and the articulation freely opened, so as to allow the effused fluids to escape, no retention of decomposable matter takes place, and there is therefore no septic influence brought to bear on the part, and recovery may take place without any severe local or constitutional disturbance.

If, however, the cavity becomes filled with putrescible material, decomposition speedily sets in, if this material is brought into contact with impure air; and acute inflammation running on to suppuration is the result. During the first twenty-four hours or so, the synovial membrane becomes intensely injected and red, and loses its natural lustre. Its fringes also become injected and swollen. The cavity becomes filled with a thin, turbid synovia, in which bacteria are commonly to be found on microscopic examination. The ligaments become swollen and softened. The cartilages lose their natural lustrous appearance, and become opaque and yellow, loosened from the surface of the bone, and eventually they perish and become eroded, especially in their centres, or where the two articular surfaces are in contact. The articular ends of the bones become exposed and superficially ulcerated. The inflammation extends to the structures outside the joint, which become œdematous, and in which suppuration occurs. Later on, in about a week or ten days, the joint surfaces become covered with a layer of granulation tissue, and the cavity of the joint filled with a thick creamy pus. It is now impossible to recognise the various structures, which present a uniform gelatinous appearance, infiltrated with inflammatory products. In this way, the whole of the tissues of the joint are thoroughly disorganised and destroyed, and the bone surfaces laid bare and ulcerated.

If the patient's strength has survived this protracted disintegration, a reparative process now sets in.

Granulations spring up from the exposed bony surfaces, and, coalescing, become converted into osseous matter, just in the same manner as in the union of a compound fracture, and complete synostosis takes place.

Symptoms.—If, in a case of wound of a joint, these untoward conditions are set up and the case becomes one of septic inflammation, within a few hours of the receipt of the injury great swelling of the joint comes on, accompanied by acute lancinating pain. The swelling is at first evidently due to effusion into the synovial membrane, and takes the shape of this sac; but after a time the tissues external to the joint become infiltrated, and the swelling more globular. The skin is red, hot, and œdematous. The pain rapidly increases and becomes tensive in character. If the wound is left open, synovia, turbid and opaque and mixed with shreds of lymph, escape. The limb is semiflexed. Later on the pain becomes altered in character, and is described as throbbing. The swelling and œdema around the joint increase, and the redness is of a more dusky hue. There is starting of the limb, especially at night, or as soon as the patient falls asleep. The constitutional symptoms are very severe, especially during the first ten days or so, during which time absorption readily takes place through the synovial membrane. Later on, when this structure becomes covered with granulation tissue which offers a barrier to septic absorption, the fever often becomes considerably lessened. In the early stages the temperature is very high, the thermometer sometimes registering 105° or 106°. The pulse is full and bounding; the skin hot and dry; the face flushed, and the tongue covered with a thick creamy fur. There is often nocturnal delirium, with restlessness and inability to sleep. Or should the patient

fall asleep, he will be awakened by the sudden, painful starting of his limb. Later on, when the fever lessens, it assumes a more hectic type. There are often rigors, and the patient may die from pyæmia, or, at a still later period, from exhaustion from the excessive discharge.

If the wound in the joint is small, and unites by first intention, and the patient escapes the danger of septic inflammation, there will probably be some swelling, from effusion into the joint, accompanied by heat and pain, which will pass off in the course of a few days, and the joint be completely restored, though it may be stiff and tender for some time.

Treatment.—The first question which presents itself in considering the treatment of a case of wound of a joint is as to whether any operative interference will be necessary or not. And in deciding this question much will depend upon the joint implicated, its size, and whether it is situated in the upper or the lower extremity. Wounds of the joints of the upper limb, as a rule, do much better than those of the lower. To this, however, there are exceptions, for wounds of the wrist joint are particularly dangerous, while those of the ankle, unless complicated with fracture, or extensive injury to the soft parts, often do well, and recovery takes place with a fairly useful limb. If the joint has been extensively opened, with much contusion and laceration of the edges of the wound, and especially if the articular ends of the bones are fractured or displaced, operative measures will probably be necessary. In less severe injuries an attempt should be made to save the joint. Under these circumstances, in conducting the treatment much will depend upon the nature of the wound. If it is a small puncture or a cleanly incised wound, especially if it passes obliquely into the joint, an endeavour should be made to procure union by the first intention. The wound, if sufficiently

large to require it, should be sewn up with silver wire, and coated with collodion or some other material, which will completely exclude the air. The limb must be placed on a splint, so as to secure perfect immobility of the joint, and irrigation with cold water, or spirit and water, assiduously applied. This is much to be preferred to the application of an ice bag, the weight of which is often uncomfortable and distressing to the patient. If the joint swells the case is one of considerable anxiety to the surgeon; but as long as the temperature does not rise to any considerable extent, the treatment must not be abandoned. If the pain is very severe, and tensive from the distension of the cavity, the fluid should be evacuated with the aspirator, and opium should be given to relieve pain and procure sleep. If, however, the temperature rises, and suppuration has evidently taken place, long and free incisions must be made into the joint, which must be thoroughly washed out with some antiseptic lotion, such as carbolic acid lotion or tincture of iodine and water, and free drainage must be provided for. The syringing out of the wound must be continued daily, and the part must be dressed with carbolic gauze, carbolic oil, boracic acid, lint, salicylic wool, or some such antiseptic material. If the temperature falls, and the discharge lessens, care must be taken to maintain the joint in such a position that, when anchylosis results, the patient's limb shall be of service to him. If, on the other hand, the high temperature is maintained, and the discharge continues profuse, and symptoms of hectic develop, amputation must be at once resorted to.

If the wound in the joint is a large one, and particularly if its edges are contused and lacerated so as to preclude all hope of obtaining union by first intention, the case must be treated on antiseptic principles from the first, so as to endeavour to prevent decomposition. The joint should be thoroughly washed out with

carbolic acid lotion (1 in 20), and every particle of foreign matter and blood clot carefully syringed away. A drainage tube is to be inserted, and if the wound is in such a position that complete drainage cannot be obtained, a counter-opening is to be made in the most dependent part, and a tube inserted. The external wound must now be closed by sutures, and the limb fixed on a splint and dressed with some antiseptic dressing. If, in spite of all the efforts of the surgeon, septic inflammation should supervene, the case must be treated in the manner before mentioned. Generally, however, it will be found in these cases, if antiseptic measures are rigidly carried out, that though suppuration may come on, the discharge will be very slight in amount, and will be unaccompanied by fever, and that recovery will take place with comparatively little local inflammation or constitutional disturbance by complete bony union of the articular ends.

Dislocation.

The articular surfaces of a joint may become displaced from each other, either as the result of some injury, constituting the *traumatic* form of dislocation; or from certain destructive changes taking place in the joint and surrounding tissues, so that the bony surfaces can no longer be retained in apposition. but are displaced in consequence of muscular contraction, or the weight of limb or trunk (the *pathological* form of dislocation); or lastly, from some congenital defect or malformation of the joint, in consequence of which the bones cannot remain in proper apposition (the *congenital* form of dislocation).

A dislocation may be either partial or complete; *partial*, when the articular surfaces are displaced as regards their normal relation to each other, but are not completely separated, so that some portion of the articular surface of one bone is still in contact with

some portion of the articular surface of the other; *complete*, when there is an entire separation of the two articular surfaces from each other. Dislocations may be either simple or compound. In the former the integument remains unbroken, while in the latter the displaced articular surfaces are exposed by a wound, and thus air is admitted into the cavity of the joint. A compound dislocation is one of the most serious accidents which can befall a limb. It is generally complicated with other injuries, and the lesion is usually attended with the most severe form of inflammation, which rapidly runs on to suppuration and complete destruction of the joint, so that bony anchylosis is the most favourable result which can ensue. If, however, the joint is small, as one of the phalangeal articulations, the injury may be recovered from without destruction or loss of motion.

Causes.—The causes of dislocation have to be considered under two heads, viz. (1) predisposing, (2) exciting causes. Among the predisposing causes may be classed

1. *The nature of the joint.* Ball-and-socket joints, on account of the greater freedom of motion which they enjoy, are much more liable to become dislocated than, for instance, a hinge joint, where the amount of movement is much more limited. So that it may be laid down as a rule that the greater freedom of motion there is in a joint, the greater liability there will be to dislocation. 2. *The situation of the joint.* Some joints are much more exposed to violence than others, and therefore more frequently dislocated. 3. *The age of the patient.* Dislocations generally occur in adults or middle-aged individuals; being rare in children (with the exception of those of the elbow joint) and in old people. 4. *The sex of the patient.* Males are much more liable to suffer from dislocation than females, on

account of their greater exposure to serious injuries. 5. *The condition of the structures round a joint* may predispose to dislocation; for example, where they have been stretched by previous injury or effusion.

The *exciting* causes of dislocation are two-fold; either external violence or muscular action. Violence may cause dislocation in two ways, either *directly*, from blow on one bone entering into the formation of a joint driving it directly away from the other; or *indirectly*, where a fall or blow on one part of the bone is transmitted to its extremity, and forces it away from the articular surface with which it is in contact.

Symptoms.—The signs by which a dislocation may be recognised are: (1) pain, which is usually of a severe and sickening character; (2) impaired mobility, so that the patient, to a great extent, is unable to perform the various voluntary movements of the joint; (3) change in the shape of the joint; (4) alteration in the relation of the bony prominences in the neighbourhood of the joint to each other; (5) the displaced bone can sometimes be felt in its new situation; (6) an alteration in the length of the limb; it being sometimes lengthened, sometimes shortened, according to the position of the head of the bone; (7) and an alteration in the direction of the axis of the bone.

Dislocations may sometimes be mistaken for fractures; the chief points of distinction are the impaired mobility, the absence of crepitus, and the fact that when the deformity is reduced it does not as a rule recur; whereas, in fractures, the displacement at once recurs, as soon as the extending force has been removed.

Complications.—A dislocation is always complicated with injury to the structures entering into the formation of, or in the immediate neighbourhood

of the joint. The bones, ligaments, muscles, vessels, and nerves may all suffer. The bones are very frequently fractured; in fact, in some joints, notably the ankle, dislocation rarely occurs without fracture. The injury to the bone may vary from the chipping off of some small fragment to the extensive comminution of the articular extremity of the displaced bone. Occasionally fracture of the shaft of a bone may take place, with dislocation of its extremity. This sometimes occurs in the humerus, where a dislocation of the head of the bone is complicated with fracture of the upper part of the shaft. The ligaments which connect the bones together are, as a rule, more or less torn in all complete dislocations; but in incomplete luxations they may escape laceration, being only severely stretched. The muscles which surround the joint are often much bruised and lacerated, and tendons in the neighbourhood, especially those which are connected with the capsule, are sometimes torn across. Arteries and veins in the vicinity of the joint may be compressed by the displaced bone, and all circulation through them arrested; or they may be ruptured, though on account of their elasticity, especially as regards the arteries, this does not frequently take place. Nerves in the neighbourhood may be lacerated, contused, or compressed, leading to intense pain at the time of the injury, and subsequently to paralysis of the muscles they supply.

Treatment.—In the treatment of dislocations the first indication is to endeavour to effect reduction as speedily as possible. If the patient is seen immediately after the accident, he will probably be faint and his muscles will be relaxed, and reduction can then be easily accomplished unless there is some mechanical impediment. If, on the other hand, he has rallied from the first shock of the accident, the muscles will be in a condition of active contraction, and will offer a

considerable impediment to reduction. Under these circumstances it is wiser to administer an anæsthetic.

There are two principal modes of reducing dislocations, viz. by manipulation, and extension.

Manipulation aims at reducing a dislocation by making the bone retrace the steps by which it has become displaced. This is done by executing certain movements of the limb, which shall relax the ligaments and disentangle the bones from each other, and cause the head of the displaced bone to recede into its socket, or put it in such a position as shall enable the muscles inserted into it to draw it back again into its proper place.

Extension has for its object the overcoming of muscular and other resistance by a superior force, and by the application of extension to the limb to forcibly drag the bone back into its normal situation. There can be no question as to the superiority of the former method, as being the more scientific and the less likely to cause injury to surrounding structures, and it should always be employed in the first instance; extension being reserved for those cases where manipulation has failed. Extension may be made by means of the hands of the surgeon or his assistant grasping the limb below the seat of dislocation, or if thought necessary, by a bandage or jack-towel fastened to the limb by a clove hitch. Or, if more force is required, some form of multiplying pulley must be employed.

After a dislocation has been reduced, it is necessary to maintain the joint in a fixed position for some days, otherwise the bone may easily slip out of position again, the ligaments which should retain it in place having been stretched or torn. But this fixed position should not be maintained for too long, otherwise fibrous adhesions between the injured surfaces may take place, and thus an impairment of the movements

of the joint, which it will be very difficult to remedy, may result. After about a week or ten days of perfect rest, the limb should be loosened from the bandages or splint, and passive motion should be gently and carefully applied to the joint. This proceeding should be repeated daily by the surgeon (the limb being still kept bandaged) during the intervals

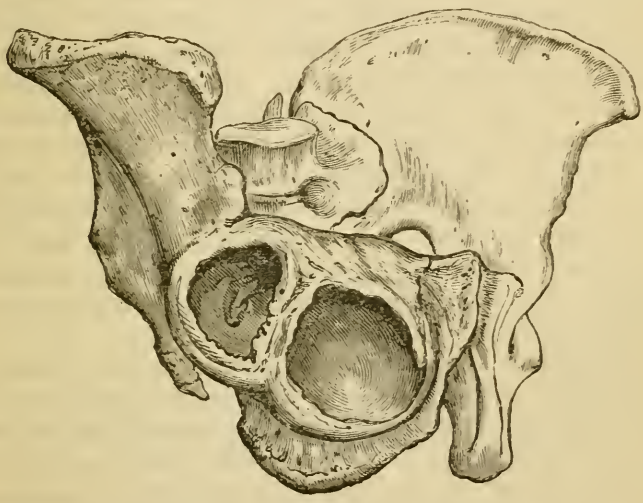

Fig. 31.—Unreduced Dislocation of the Femur.

The acetabulum has been partially filled with a dense fibroid material, and a new cavity formed for the head of the thigh bone. (After Astley Cooper.)

of his visits for some time longer, lest some incautious movement of the patient should induce a recurrence of the displacement.

Unreduced dislocations.—If a dislocation is allowed to remain unreduced, great and important changes take place both in the old cavity from which the bone has been separated, in the displaced bone itself, and in the tissues against which it rests in its new position. In the ball-and-socket joints the old cavity generally becomes filled up with a fibroid material,

and its circumference becomes contracted and less regular; the head of the bone becomes altered in shape; its encrusting cartilage becomes absorbed, or else becomes converted into a dense connective tissue; the structures against which the head of the bone rests become hollowed out, forming a cavity lined by a dense fibroid material, which sometimes partially ossifies. Between the two bones a synovial sac becomes developed, and the cellular tissue around them becomes infiltrated with plastic matter and forms a complete capsular investment. Thus a fairly perfect false joint is formed, in which, under favourable circumstances, a considerable range of movement may be allowed. In the hinge joints the articular ends are altered in shape so as to be scarcely recognisable, the bony processes become rounded off, and the extremities of the bones present a stunted, angular outline; the cartilages covering them become metamorphosed into connective tissue.

Secondary changes take place in the neighbouring structures; muscles shorten and atrophy, and, if not used, undergo fatty degeneration; vessels and nerves become incorporated in the altered structures in the neighbourhood of the new joint, and their functions partially interfered with, and all the injured tissues more or less infiltrated with a dense cicatricial material.

The amount of movement which may be obtained in an unreduced dislocation will depend, in a great measure, on the nature of the joint, very much more motion, as a rule, being possible in a ball-socket than a hinge joint.

In determining the question as to whether an attempt should be made to reduce an old dislocation, the introduction of anæsthetics has led us very considerably to modify the old rule laid down by Sir Astley Cooper, that it was improper to attempt the

reduction of a dislocation of the shoulder which had existed for a longer period than three months, or of the hip that had been allowed to remain unreduced for more than eight weeks. Under the influence of an anæsthetic dislocations have been reduced after a much longer period than this, though it is always doubtful, when they have existed for a very long time, whether, if reduced, the limb would gain or lose in utility. In coming to a decision as to the advisability or not of attempting reduction, the amount of pain produced by moving the displaced bones on each other should always be taken into account. If the patient can move his limb without much pain, there is a fair prospect of his obtaining a serviceable false joint; but if, on the other hand, any attempt to move his limb causes him pain, it is better to attempt reduction, as the patient will not be induced to sufficiently exercise his false joint to enable him to obtain any great degree of motion in it. In attempting the reduction of an old-standing dislocation, all adhesions must be first thoroughly broken down, and then an effort be made to replace the bone by manipulation or extension.

Special Dislocations.

Dislocation of the lower jaw.—The lower jaw can only be dislocated in one direction, viz. forwards (Fig. 32), unless accompanied by fracture. One or both condyles may be displaced. The former, the "bilateral," is the more common of the two, being met with in about three to every two cases of "unilateral" dislocation.

Causes.—This injury can only take place when the mouth is widely open. Under these circumstances the condyle of the jaw is situated near the summit of the eminentia articularis, and either muscular contraction or violence may cause it to become

displaced forwards by forcing it over the summit of the ridge. Thus the jaw is liable to become displaced during the act of yawning, shouting, or vomiting; or it has been known to occur during the extraction of a tooth, the passing of a stomach-pump tube, or in taking a cast of the mouth.

Symptoms.—When the dislocation is *bilateral*, the mouth is wide open and the lower jaw advanced

Fig. 32.—Dislocation of the Lower Jaw.
Showing the position of the condyle of the jaw in dislocation forwards.

in front of the upper. It is fixed and almost immovable. The chin is carried forwards, and the face, when viewed in profile, appears to be elongated. The lips cannot be approximated, and hence there is dribbling of saliva, and deglutition and speech are impaired. The condyle can be felt in front of its natural position, where a distinct hollow is to be perceived.

In the *unilateral* dislocation the symptoms are not so marked, and the chin is generally inclined to

the opposite side to that on which the dislocation has taken place. The condyle can be felt in its natural situation on the sound side, and a certain degree of movement is possible.

Treatment.—Reduction can usually be effected by introducing the thumb, guarded with a napkin, into the mouth and making pressure downwards and backwards on the lower molar teeth, at the same time that the chin is elevated with the fingers; or a wedge may be inserted between the molar teeth on one or both sides, according as the dislocation is unilateral or bilateral, and the chin forced directly upwards. Sir Astley Cooper recommends that the end of a piece of wood about a foot long should be introduced between the molar teeth of the two jaws; by raising the other end of the wood, the lower molars are depressed, the upper teeth acting as a fulcrum, and the jaw levered back into its place. Nélaton believed that the immobility of the jaw and the difficulty in reduction arose from the coronoid process becoming fixed against the malar bone. He therefore recommends that reduction should be effected by directly pressing on these processes and forcing them backwards.

After reduction the jaw is to be fixed with a four-tailed bandage for at least a week, after which passive motion must be cautiously and regularly applied. The jaw, having once been dislocated, is very liable to become again displaced, and in some cases the structures around the joint become so lax that the accident is constantly recurring.

In old-standing dislocations an attempt should always be made to reduce it, for, even if it does not succeed, the effort will do some good by increasing the mobility of the bone in its new situation.

Dislocation of the clavicle.—The clavicle may be dislocated at either extremity; either from

the sternum internally, or from the acromion process of the scapula externally.

Dislocation at the *sternal* end may take place in three directions, viz. forwards, backwards, and upwards, named in their relative order of frequency.

Dislocation **forwards** is caused by violence applied to the front of the acromial end of the bone, as falls or severe blows on the front of the shoulder. This causes the sternal end of the bone to start forwards, a severe strain is put upon the ligaments of the articulation, they give way, and a dislocation results. The end of the bone is thrown forwards, downwards, and inwards, and rests on the anterior surface of the manubrium.

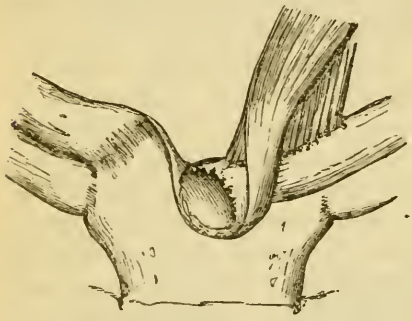

Fig. 33.—Dislocation of the Sternal end of the Clavicle forwards.

Symptoms.—The signs of the injury are very marked, the prominence of the displaced bone on the front of the sternum being very characteristic. The shoulder is approximated to the median line, and all movements of the upper extremity are attended with pain. The only injury for which it is liable to be mistaken is fracture of the sternal end of the clavicle; but the abrupt outline of the projection, and the presence of crepitus is generally sufficient to distinguish this lesion from dislocation.

Treatment.—Reduction is to be effected by drawing the shoulders forcibly backwards, with the knee placed in the middle of the patient's back, between the two scapulæ. After reduction there is often the greatest difficulty in maintaining the bone

in position. This is best done by placing a large pad in the axilla, and applying a figure of 8 bandage to the shoulders. It is a good plan to instruct the patient to wear an ordinary hernia truss over the joint for some time after the injury, as a recurrence is very likely to occur.

Dislocation **backwards** may be produced either by direct or indirect violence; by indirect violence, when a force is applied to the shoulder, driving it forwards and inwards; or by direct violence when a force is applied directly to the inner end of the clavicle. The articular end of the bone may be displaced backwards, and either a little downwards or upwards from its normal position; in the former instance lying behind the first piece of the sternum, in the latter lying above the level of the upper border of this bone.

Symptoms.—There is a well-marked depression at the sterno-clavicular articulation, and the end of the clavicle can be felt at the front of the neck, or else it will be found to have disappeared behind the sternum. There is approximation of the shoulder to the median line of the body, and pain and inability to use the extremity. The head is inclined to the injured side. In addition to this, special symptoms may be present owing to pressure on neighbouring parts. There may be dyspnœa from pressure on the trachea; dysphagia from pressure on the œsophagus; or congestion of the head and face, and perhaps even semicoma, from pressure on the large veins at the root of the neck.

Treatment.—Reduction may generally be accomplished, as in the dislocation forwards, by placing the knee in the middle of the back, between the two scapulæ, and forcibly drawing the two shoulders backwards. To retain the bones in position a large pad should be placed over the spine and a figure of 8

bandage tightly applied over the points of the shoulders. There is often great difficulty in retaining the bone in its place, and when this is so, and there are urgent symptoms of dysphagia or dyspnœa, it may become necessary to excise the end of the clavicle.

Dislocation **upwards** is of very rare occurrence, and can only be produced by indirect force applied to the shoulders in a very unusual direction, so that it is forced downwards and inwards. The end of the bone is carried inwards as well as upwards, and rests on the upper border of the sternum, between the sterno-mastoid and sterno-hyoid muscles.

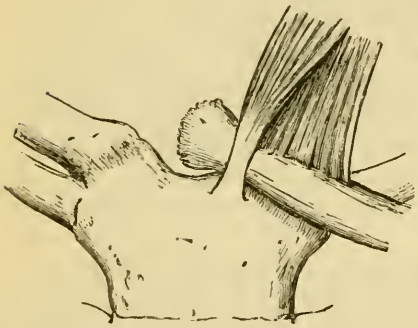

Fig. 34.—Dislocation of the Sternal end of the Clavicle upwards.

Symptoms.—The sternal end of the clavicle forms a prominent swelling in its new position, in front of the trachea. The axis of the clavicle is directed forwards and upwards, and there is a considerable interval between it and the first rib. There is loss of motion in the extremity and approximation of the shoulder to the mesial line of the body.

Treatment.—In order to effect reduction a large and hard pad should be placed in the axilla to act as a fulcrum, and the elbow pressed well in to the side of the chest. At the same time the end of the bone must be forced downwards by direct pressure upon it. In order to retain the bone in position after reduction, a pad must be placed in the axilla and the arm bound to the side, the shoulder being at the same time raised by carrying the bandage under the point

of the elbow and over the opposite shoulder. This may be supplemented, if necessary, by a pad over the joint, securely bandaged so as to make direct pressure on the sternal end of the bone.

Dislocation of the **acromial end** of the clavicle ought more correctly to be described as dislocation of the acromion process of the scapula, in accordance with the usual nomenclature of dislocations, where the more distal bone is the one usually spoken of as being dislocated.

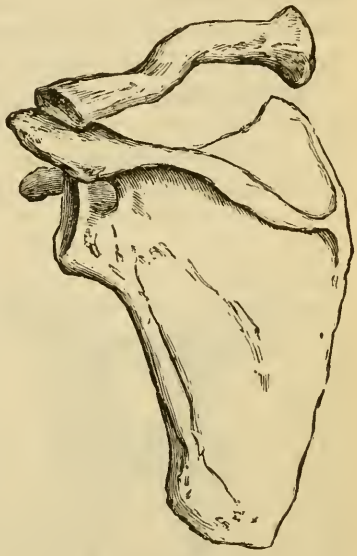

Fig. 35.—Dislocation of the Acromial end of the Clavicle.

This injury is more common than dislocation at the sterno-clavicular joint, and almost invariably takes place in one direction, that is to say, the clavicle is displaced upwards on to the acromion process. Some few cases have, however, been recorded where it has been displaced beneath this process. It is generally caused by a direct blow on the scapula, especially if the blow be given from behind, so as to drive the point of the shoulder forwards.

Symptoms.—The signs of the ordinary dislocation are unmistakable. There is a marked prominence, produced by the outer end of the clavicle riding on the top of the acromion process of the scapula; the shoulder is depressed and approximated to the middle line of the body, and the patient is unable to raise his arm upwards over his head.

Treatment.—Reduction can generally be accomplished by drawing the points of the shoulders backwards, and at the same time making direct pressure on the prominent end of the clavicle; but there is great difficulty in maintaining the parts in apposition after reduction. This is best done by placing a pad over the joint and firmly strapping it in this position by a broad webbing carried over it and round the point of the elbow, and afterwards binding the arm to the side.

Dislocation of the humerus. — Dislocations of the shoulder occur much more frequently than at any other articulation. The head of the humerus may be displaced in five different directions, viz. (1) forwards, inwards, and slightly downwards (the *subcoracoid*); (2) downwards, and slightly forwards, and inwards (the *subglenoid*); (3) backwards, inwards, and slightly downwards (the *subspinous*); (4) forwards, inwards, and upwards (the *subclavicular*); and (5) forwards and upwards (the *supracoracoid*).

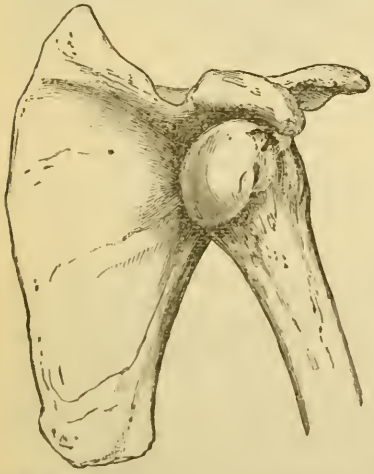

Fig. 36.—Subcoracoid Dislocation of the Humerus.

1. **Subcoracoid.**—This is by far the most common form of dislocation of the shoulder joint. The head of the bone is thrown forwards, inwards, and slightly downwards, so that the anatomical neck of the humerus rests on the anterior edge of the glenoid cavity, immediately below the coracoid process of the scapula. It lies above the tendon of the subscapularis muscle, which is frequently torn; when this is not

the case, the neck of the bone is embraced by the fibres of the muscle, and this often proves to be a serious impediment to reduction.

Causes.—This form of dislocation may be produced either by a direct blow or fall upon the shoulder, the force being inflicted in such a manner as to drive the head of the bone forwards and inwards; or by falls on the elbow or hand, when the arm is extended from the side. In these latter cases it would seem probable that in many instances the head of the bone is primarily displaced downwards, and that the subsequent alteration in its position to beneath the coracoid process is due to muscular contraction, or to the direction in which the violence was applied.

Symptoms.—In many particulars the signs of all forms of dislocation of the shoulder joint are the same, and it is principally by the alteration in the direction of the axis of the bone, by its lengthening or shortening, and by the presence of the head of the bone in its new situation, where it can be felt, that the differential diagnosis between the various forms can be established. The signs common to all dislocations of the shoulders are: (1) pain; (2) flattening of the shoulder; (3) apparent projection of the acromion process; (4) a depression beneath this process; (5) rigidity or impaired mobility about the joint; and (6) the presence of the head of the bone in a new situation. To these may be added two special signs, which will be found useful in substantiating the diagnosis in doubtful cases. The one was pointed out by the late Mr. T. Callaway; it consists in taking the vertical circumference of any shoulder in which dislocation exists by means of a tape carried over the acromion and under the axilla, when an increase of about two inches over the sound side will be found to be an invariable concomitant. The other is known as Dugas's guide. "If the fingers of the injured limb can be

placed by the patient, or by the surgeon, upon the sound shoulder, while the elbow touches the thorax, a condition that obtains in the normal condition of the joint, there can be no dislocation."

The principal signs by which the subcoracoid dislocation may be diagnosed from the other forms are: (1) An alteration in the direction of the axis of the bone. The elbow is generally thrown backwards and away from the side, and the bone is directed inwards, away from its normal direction. (2) The head of the bone can sometimes, in thin persons, be easily felt beneath the coracoid process; but in stout people it cannot always be perceived, though even in these there is generally a greater fulness than natural of the anterior fold of the axilla. (3) There is usually a very slight lengthening of the arm.

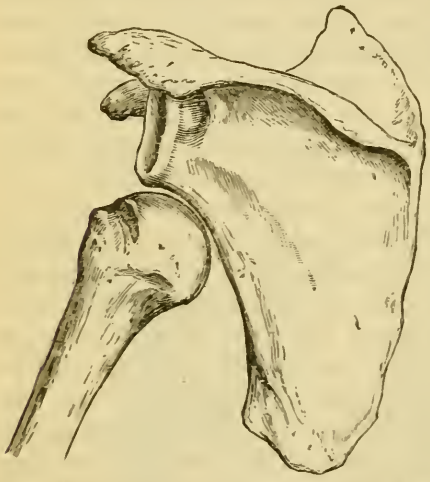

Fig. 37.—Subglenoid Dislocation of the Humerus.

2. **Subglenoid.**—In this dislocation the head of the bone is displaced downwards, and at the same time a little forwards and inwards. It rests on the axillary border of the scapula, just below the glenoid cavity, between the subscapularis above, the long head of the triceps behind, and the teres muscles below.

Causes.—It is caused much in the same way as the subcoracoid dislocation, by falls on the elbow or hand when the arm is extended away from the side.

When the arm is in this position the head of the bone projects below the lower margin of the glenoid cavity and stretches the inferior part of the glenoid ligament. Any sudden force applied to the limb while the bone is in this position tears the ligament, and the head of the bone becomes displaced downwards into the axilla. If it remains in this position, a subglenoid dislocation is the result, but in the majority of instances it is forced away from this position by a continuance of the violence which caused the primary displacement, or is drawn upwards by muscular action and one of the other forms of dislocation results.

Symptoms.—The common signs which characterise all dislocations of the shoulder are more pronounced in this form than in the preceding, and there are, in addition to these, certain special signs by which this dislocation may be differentiated from the others. The elbow is thrown considerably away from the side, and there is not the same inclination backwards as in the subcoracoid variety. Instead of the fulness of the anterior fold of the axilla, which was present in the subcoracoid dislocation, there is in these cases a depression, due to drawing downwards of the pectoralis major at its attachment to the humerus. The head of the bone can be felt in the axilla, and there is considerable lengthening of the arm.

3. **Subspinous.**—In this dislocation the head of the bone is driven backwards and downwards, and rests on the back of the scapula in the infraspinatus fossa, immediately beneath the spine and between the infraspinatus and teres minor muscles. Malgaigne has also described another variety, in which the head rests beneath the acromion process. It seems, however, to be merely a less complete form of the same luxation, and differs only in the fact that the symptoms are not so marked.

Causes.—This form of dislocation may be

produced by direct violence, *i.e.* by blows struck on the front of the shoulder; or by indirect force, in the same way as the subcoracoid dislocation, the initial displacement being downwards, and the head of the bone being subsequently forced or drawn into its position beneath the spine. The reason why the displacement in these cases is generally forwards (subcoracoid), is probably on account of the great pectoral muscle, passing from the front of the chest to the upper part of the humerus, having a tendency to pull the bone in this direction.

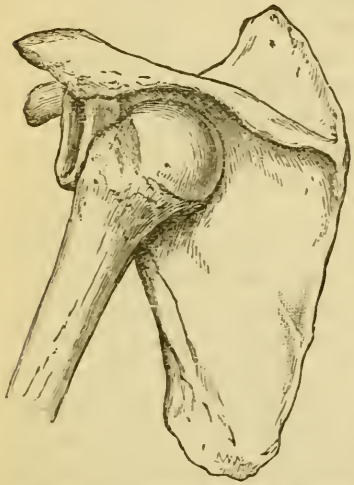

Fig. 38.—Subspinous Dislocation of the Humerus.

Symptoms.—In the subspinous dislocation, in addition to the symptoms common to all forms, we find that the axis of the humerus is directed backwards, so that the elbow is advanced in front of the body, and the bone is at the same time rotated inwards, so that the forearm is thrown across the front of the chest. There is some lengthening of the arm. The head of the bone forms a considerable prominence on the dorsum of the scapula, and there is a marked depression beneath the coracoid process.

4. **Subclavicular.**—This form of dislocation is very rare, and is an exaggerated form of the subcoracoid. The head of the bone is thrown forwards and inwards, and also upwards, so that it rests on the front of the chest, internal to the coracoid process, and immediately beneath the clavicle.

Causes.—The dislocation requires great force to produce it, and is caused by the head of the bone being violently driven against the anterior part of the capsular ligament. There is, therefore, in these cases considerable laceration of the muscles attached to the tuberosities of the humerus.

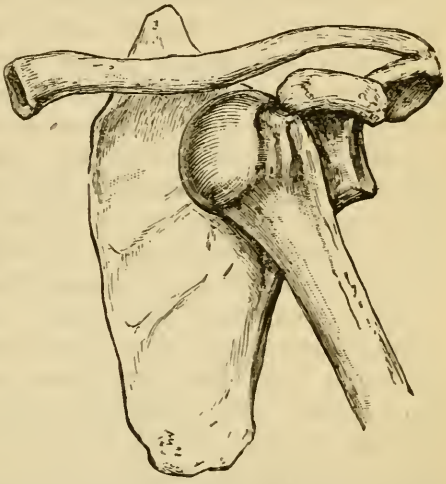

Fig. 39.—Subclavicular Dislocation of the Humerus.

Symptoms.—There is generally no difficulty in at once coming to a decision as to the nature of the case, the presence of the head of the bone in its new situation being most palpable, so that it can be not only felt, but seen, forming a globular prominence beneath the pectoral muscle. On account of the great displacement, the acromion is very prominent, and the hollow beneath it well marked. There is shortening of the arm, and the elbow is carried outwards and backwards.

5. **Supracoracoid.**—This is a mixed form of accident, the dislocation being secondary to fracture of the coracoid process. The head of the bone rests between the fractured coracoid and acromion processes, in contact with the anterior border of the clavicle. As far as I am aware, only three cases of this injury have been recorded.

Treatment.—There are three different modes of reducing dislocations of the shoulder joint: (1) by

manipulation; (2) by extension; (3) by mechanical appliances.

By *manipulation.*—The simple plan recently introduced by Kocher appears to be the most efficient means of reducing dislocations by manipulation. The patient is seated in a chair, and the surgeon, standing in front of him, gently presses the elbow to the side, the fore-arm having first been flexed on the arm. The humerus is now rotated outwards until the fore-arm is at a right angle with the body. In many cases this is all that is necessary, and the head of the bone will be felt to recede into its place. Should it not do so, the elbow is now to be raised from the body and rotated inwards, until the hand reaches the opposite shoulder.

By *extension.*—There are several plans by which dislocations of the shoulder may be reduced by extension. The simplest and best is by *the heel in the axilla.* The patient is placed on a low couch, and the surgeon, seated on its edge and facing the patient, places his heel in the axilla, and, taking the patient's wrist, draws the arm steadily downwards. After sufficient extension has been made, should the bone not recede into its place, as it often does, he brings the arm across the front of the patient's chest. The foot then, acting as a fulcrum, forces the head of the bone upwards and outwards, and so effects reduction. Another plan, which sometimes succeeds when others fail, consists in laying the patient flat on his back, and having fixed the scapula by means of a jack-towel passed over the shoulder girdle, and held by an assistant standing at the foot of the bed, making extension vertically upwards.

Many other plans, too numerous to mention, have been advocated at different times, all of which have proved efficient. It will generally be found, however, that one or the other methods mentioned above will succeed in effecting reduction, unless in the case of

old unreduced dislocation, when it may be necessary to have recourse to the pulleys.

By *pulleys.*—The patient having been brought thoroughly under the influence of an anæsthetic, all adhesions are to be thoroughly broken down. The scapula is fixed by a leather collar, which encircles the shoulders, and is fastened to a staple on the sound side of the patient. The pulleys are to be attached to the lower end of the humerus, and extension made in a horizontal direction and continued until the head of the bone is felt to move, when the surgeon should endeavour to manipulate or push the bone into place. After reduction the arm must be bandaged to the side, with a pad in the axilla, and maintained in this position for a week. Passive motion must then be commenced. The surgeon must daily remove the bandage, and carefully and cautiously move the joint in every direction; the arm being still kept bandaged, between his visits, for another three weeks, when the patient may be allowed to begin to use his arm, at first with care, and he should avoid all violent exercise for some time longer.

Accidents occasionally occur in reducing old-standing dislocations of the shoulder joint. Of these, rupture of the axillary artery is the most common, and would appear to result, in some cases, from the vessel having become adherent to the bone, and becoming lacerated in breaking down the adhesions. The axillary vein may also be injured, though less commonly than the artery. The humerus may be fractured, the brachial plexus bruised or lacerated, and finally the skin, subcutaneous tissue, and muscles torn, as the result of excessive force employed in the reduction of a dislocation.

In determining the point as to whether an attempt should be made to reduce an old standing dislocation of the shoulder, a great deal must depend

upon the amount of motion which the patient enjoys, and how far this motion can be carried on without pain. If, after three months or longer, there is a fair amount of movement of the head of the bone in its new situation, it is better to abandon all attempts at reduction, since the patient will probably have a more useful arm than if the attempt at reduction succeeded, without being exposed to the risks which must attend such a proceeding.

Dislocation of the elbow. — Dislocation of the elbow joint is a common accident, occurring frequently in young people. Both bones may be displaced backwards, forwards, inwards, or outwards ; or a combination of two of these forms may occur, and both bones be dislocated backwards and outwards, or backwards and inwards. One bone only may be displaced; thus, the ulna may alone be displaced backwards, or the radius may be dislocated forwards, backwards, or outwards.

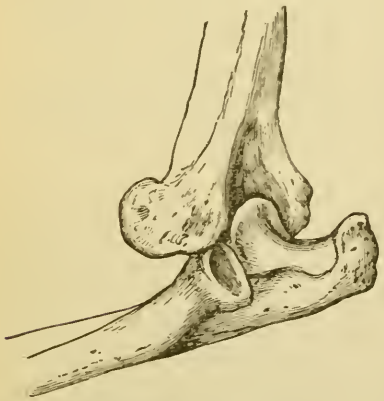

Fig. 40.—Dislocation of both Bones of the Fore-arm backwards.

Dislocation of both bones of the fore-arm backwards.—This is by far the most common luxation of the elbow, and is usually caused by falls on the palm of the hand. The dislocation may be complete or incomplete. In the complete form the coronoid process of the ulna is lodged in the olecranon fossa of the humerus, while in the incomplete form it rests on the trochlear surface of the bone. In some cases the dislocation is complicated with

fracture of the coronoid process, but as a rule this does not occur.

Symptoms.—There is considerable deformity about the joint, the olecranon stands out prominently behind the elbow, and the triceps can be felt to be separated from the bone. In front of the joint the rounded end of the humerus can be plainly perceived. The head of the radius forms a globular swelling behind the external condyle. The fore-arm is flexed and supinated, and there is undoubted shortening. The injury may be mistaken for transverse fracture of the lower end of the shaft of the humerus; but in these cases the relative position between the condyles and the olecranon process is unaltered, and this constitutes a ready means of distinguishing the one injury from the other.

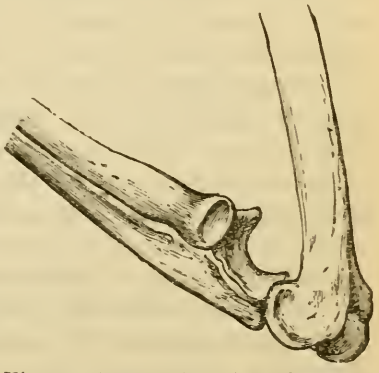

Fig. 41.—Dislocation of the Bones of the Fore-arm forwards. (After Bryant.)

Dislocation of both bones of the fore-arm forwards.—This is a very rare form of dislocation, and can only take place when the fore-arm is in a condition of extreme flexion, and usually occurs from falling backwards on the point of the elbow. The dislocation may be complete or incomplete. When complete the olecranon is quite in front of the condyles; in the incomplete form the tip of this process rests against the articular surface of the humerus.

Symptoms. — The fore-arm is considerably lengthened and usually bent on the arm. The prominence of the olecranon is entirely lost, and the condyles of the humerus can be felt at the back of

the joint, with the triceps muscle tightly stretched over them. The sigmoid cavity of the ulna and the head of the radius can usually be felt at the front of the bend of the elbow.

Lateral dislocation of both bones of the fore-arm.—The lateral dislocations of the elbow are almost always incomplete, the luxation outwards being the more common of the two. In the outward dislocation, the sigmoid cavity of the ulna rests against the capitellum or radial head of the humerus, and the radius projects beyond the external condyle. In the dislocation inwards, the sigmoid cavity of the ulna rests against the internal condyle, and in consequence of the fore-arm becoming pronated the head of the radius lies a little below and in front of the articular surface of the humerus.

Symptoms.—In both forms of dislocation there is great distortion and increased width of the joint. The fore-arm is flexed and pronated. In the dislocation outwards the head of the radius can generally be recognised forming a prominent swelling, and in the dislocation inwards there is a marked and elongated projection on the inner side of the joint, caused by the internal border of the great sigmoid cavity. In both the relation of the olecranon to the condyles is altered.

The dislocations *backwards* and *outwards* and *backwards* and *inwards* differ from the common dislocation backwards merely in the fact that the bones of the fore-arm are thrown a little to the radial or ulnar side of their normal position, and therefore the tip of the olecranon will be found to be approximated to one or the other condyle.

Dislocation of the ulna alone is a very rare form of injury, and one about which we know very little. It always takes place backwards, and may be recognised by the projection of the olecranon

behind the joint, at the same time that the head of the radius is felt rotating in its natural position.

Treatment.—In all the above described dislocations, reduction can generally be effected by the same plan. The patient is seated on a chair, and the surgeon, standing in front of him, places his foot on the chair and his knee in the bend of the injured elbow, so that it shall press against the upper part of the bones of the fore-arm. He at the same time takes hold of the patient's wrist and slowly and forcibly bends the fore-arm, and the reduction is soon effected. Others recommend that the knee should be pressed against the lower end of the humerus, and the fore-arm forcibly extended, and then flexed. In old-standing dislocations all adhesions must first be thoroughly broken down before any attempt is made at reduction, and in some cases it will be found necessary to resort to pulleys. It rarely happens that reduction can be effected after a longer period than five or six weeks, and there is great danger in using the pulleys, if much force is employed, of fracturing the humerus.

Dislocation of the head of the radius.—The head of the radius may be dislocated *backwards* and *forwards*, and also, though rarely, in a direction *outwards*. There appears to be considerable difference of opinion as to whether the forward or backward dislocation is the more common. The injury in both cases is produced in the same way, by falls on the hand: in the one instance, the lower end of the radius being driven backwards and the head tilted forwards, producing the anterior dislocation; in the other the whole bone being driven backwards and the head displaced on to the back of the condyle.

In the *forward* dislocation the fore-arm is semi-flexed and fixed midway between supination and

pronation, and the head of the radius can be felt in the hollow just above the external condyle.

In the *backward* dislocation the fore-arm is slightly flexed and maintained in a position of pronation. The limb is inclined outwards from the elbow point. The head of the radius can be felt forming an easily recognised projection behind the external condyle.

Dislocation outward is a very rare form of injury, in which the head of the bone is displaced outwards and upwards above the external condyle. It can be easily detected in this situation beneath the skin, which is tightly stretched over it, and can be felt rotating during supination and pronation of the fore-arm.

Treatment.—These various dislocations of the radius may be reduced in the same way. The upper arm is to be grasped by an assistant just above the elbow, and firmly held. The surgeon then extends the wrist, and after he judges that sufficient extension has been made, suddenly flexes the fore-arm on the arm, at the same time endeavouring to push the head of the radius back into its place.

Dislocation of the wrist is a very rare accident, and is caused by falls on the hand. The bones of the carpus may be displaced either backwards or forwards, the former being much the more common accident of the two; and the deformity which is produced resembles very much a Colles's fracture, but the position of the styloid processes and their relation to each other and to the bones of the hand at once establishes the distinction. These dislocations are to be reduced by extension.

Dislocation of the radius from the ulna may take place at the radio-carpal joint from violent twists. The radius may be displaced either forwards or backwards.

The carpal bones are not often displaced from one

another. The most frequent dislocation is that of the head of the os magnum, from violence, during extreme flexion of the wrist. The head of the bone is easily to be recognised as a prominent globular swelling on the dorsum of the hand.

The most common dislocation in the hand is that of the proximal phalanx of the thumb from its metacarpal bone. The phalanx is generally displaced backwards, and the head of the metacarpal bone being driven forwards is buttonholed between the two bellies of the flexor brevis pollicis, often causing great difficulty in reduction. The thumb presents a very characteristic deformity. The proximal phalanx is bent backwards almost to a right angle with the metacarpal bone, and at the same time the terminal phalanx is flexed. The head of the metacarpal bone can be felt on the palmar aspect. Reduction is to be effected by forcibly adducting the metacarpal bone into the palm of the hand, by bending the phalanges backwards and hyper-extending, and then, by suddenly flexing the thumb on the metacarpal bone, reduction may be accomplished. If this does not succeed it will be

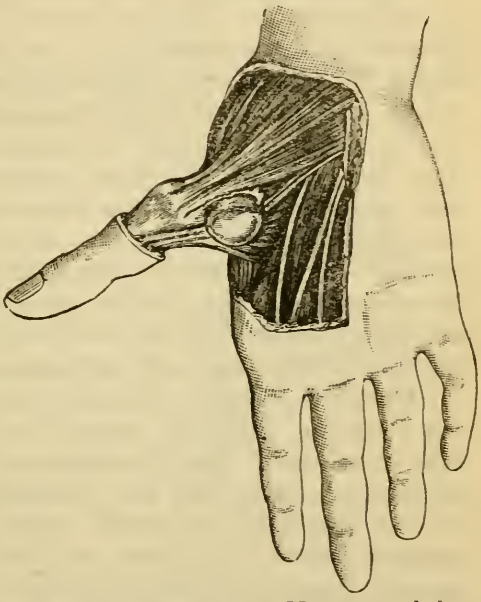

Fig. 42.—Dislocation of the Metacarpo-phalangeal Joint of the Thumb.

necessary to divide subcutaneously the tendons of the flexor brevis pollicis, or, as Dr. Humphrey has suggested, draw them aside with a hook, introduced through an incision made on either side of the joint. Luxations of the other joints but rarely happen, except as the result of severe crushing violence, and present nothing special as to their nature or treatment.

Dislocation of the hip.—The hip joint may be dislocated in four different directions, viz. (1) upwards and backwards, on to the dorsum of the ilium, (2) backwards, into the sciatic notch, (3) downwards, into the obturator foramen, and (4) inwards, on to the pubes. It must be borne in mind, however, that the head of the bone does not always occupy the same position in these dislocations, but may, as Mr. Bryant says, "rest at any point around its jacket." These varieties are therefore only adopted for purposes of classification and description, and as indicating generally the various directions in which the head of the bone may be displaced.

Causes.—There seems to be very good ground for believing that the majority of luxations of the hip, unattended with fracture, are primarily dislocations downwards, and are produced while the thigh is in a condition of forced abduction, and that the position which the head of the bone will subsequently occupy depends upon the amount of flexion and rotation which may be present at the moment of the accident. When the thigh is abducted the greatest strain is put upon the weakest part of the capsular ligament. The head of the femur bulges over the lower and inner shallow margin of the cotyloid cavity, and presses against and strains the lower and inner, that is, the weakest part, of the capsular ligament. If any severe force is now applied this portion of the ligament gives way, and the head of the bone is primarily displaced downwards. If at this time the

limb is in a condition of flexion and inward rotation, the initial violence which produced the dislocation being continued, the head of the femur is forced round the lower and outer margin of the cavity, and dislocation backwards, or backwards and upwards, is the result. If, on the other hand, the thigh is extended and rotated outwards, the head of the bone is forced in the opposite direction, round the inner margin of the cavity, producing dislocation on to the pubes. Whereas, if the abduction is unaccompanied by rotation in either direction, the bone remains in the primary position into which it was displaced, that is to say, downwards. Though this is true of the majority of dislocations of the hip, it seems probable that the dislocation backwards can take place directly, and this even without fracture of the acetabulum.

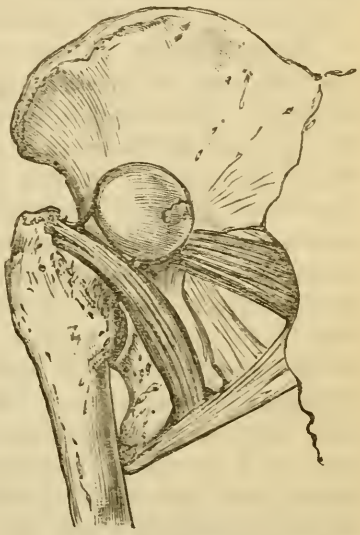

Fig. 43.—Dislocation on to the Dorsum of the Ilium.

Dislocation on to the dorsum ilii.—This is the most common form of dislocation of the hip, occurring as frequently as the other three dislocations together. The head of the bone generally rests on the dorsum of the ilium, just above the facet which marks the origin of the reflected head of the rectus muscle, but may vary in position. Sometimes it is situated considerably higher on the dorsum; sometimes in advance of this position, in some cases so much so

that the head of the bone rests in the notch between the anterior superior and anterior inferior spinous processes of the ilium. This is known as the "supra-spinous" dislocation. The head of the bone is always above the obturator internus muscle, and it is from this circumstance that Bigelow distinguishes it from the sciatic dislocation; the one luxation being "above," the other "below the obturator internus."

Symptoms.—There is a marked distortion about the hip, which appears to be wider and flatter than natural. The trochanter is less prominent, and approximated to the crest of the ilium; the head of the bone can generally be felt beneath the glutei muscles; the limb is considerably shortened, sometimes as much as two or three inches; the thigh is flexed, rotated inwards and adducted so that the axis of the femur runs across the lower third of the sound thigh, and if the patient were in the erect position the ball of the great toe would rest on the sound ankle. The voluntary movements of the joint are quite abolished, and only a slight amount of passive flexion, adduction, and inversion is permitted. The vessels in the groin may be noticed to have lost their support, and a hollow behind them can generally be easily perceived. The dislocation may be diagnosed from fracture of the neck of the thigh bone by the fixed position of the limb, by the inversion, by the absence of crepitus, and the presence of the head of the bone in its new position.

Treatment.—An endeavour should always be made, in the first instance, to effect reduction by manipulation. The patient must be placed on his back on a low couch or the floor, and thoroughly anæsthetised. The surgeon stands over his patient and flexes the leg on the thigh and the thigh on the pelvis. The flexion is to be carried to its extreme limits; the knee being at the same time

somewhat adducted and brought well over the middle line of the body. While the flexion is maintained the limb is to be abducted to its fullest extent, and then rotated outwards and brought suddenly down into the extended position. By this series of manœuvres the head of the bone will be made to retrace the steps by which it has been dislocated, and reduction will generally be accomplished. Should it not succeed, recourse must be had to extension by means of pulleys. The patient must be laid on his sound side, and the pelvis fixed by a perineal band attached to some stationary object behind the patient's head. The pulleys are to be connected to the lower part of the thigh, which is to be flexed on the abdomen, and extension made at right angles to the trunk. Sir Astley Cooper recommended that the patient should be laid on his back and extension made across the lower third of the sound thigh. But this plan would endanger the integrity of the ileo-femoral ligament, which must be tense, with the thigh extended; whereas, it is relaxed when the thigh is flexed and would thus facilitate reduction.

2. **Dislocation backwards.**—In this dislocation the head of the bone may rest on any part of the posterior surface of the ischium, below the obturator internus muscle. It may rest on the margin of the notch, or on the structures passing through it. It may rest on the spine of the ischium or against the tuberosity, opposite the smaller sacro-sciatic foramen.

Symptoms.—The signs by which the dislocation backwards is characterised are very similar to those of the iliac dislocation, but are less pronounced and less marked. There is distortion and flattening about the hip, and the trochanter is displaced, though not to the same extent as in the former dislocation; it is usually a little above and some distance behind its normal situation. There is shortening to the extent

of about an inch. The thigh is flexed, rotated inwards and adducted, though to a less extent than in the dorsal dislocation. So that, with the patient in the erect position, the ball of the great toe rests on the great toe of the sound foot. The axis of the femur is directed across the sound knee, instead of across the lower third of the thigh. The facility with which the head of the bone can be felt will depend in a great measure upon its position. In some cases it can be made out with ease; in others it can only be perceived with the greatest difficulty, or perhaps not at all. Active movement and almost all passive movement is abolished, flexion being the only motion which is permitted.

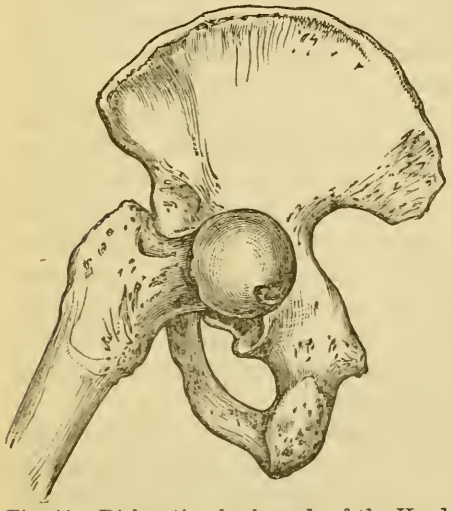

Fig. 44.—Dislocation backwards of the Head of the Femur.

Treatment.—Reduction is to be effected in the same manner as was employed for the dorsal dislocation, and will generally be accomplished by manipulation, without the aid of the pulleys. By flexing the thigh on the pelvis, abducting and rotating outwards, the head of the bone is made to retrace its steps, just as in the dorsal dislocation, and it is, without difficulty or any great expenditure of force, returned to its socket. If failure should attend the attempt to reduce the dislocation by manipulation, the pulleys must be applied in the same manner as in the previous

case. The patient must be laid on his sound side, and with the thigh flexed as much as possible on the pelvis, extension made at right angles to the trunk. This may be supplemented, if there is any difficulty, by a bandage or towel placed under the upper part of the thigh and pulled directly upwards. This will assist in raising the head of the bone over the margin of the acetabulum.

3. **Dislocation into the obturator foramen.** — In this dislocation the head of the bone generally rests on the obturator externus muscle, close to the inner margin of the obturator foramen; but in some instances it may be displaced still farther inwards, and rest on the rami of the pubes and ischium, at about their point of junction.

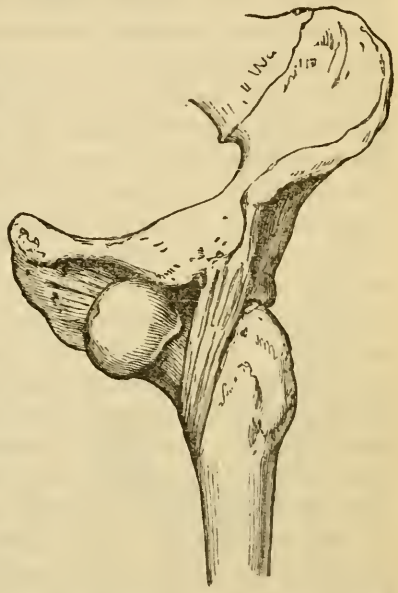

Fig. 45.—Dislocation of the Femur downwards into the Obturator Foramen.

Symptoms.— There is an appearance of flattening and deformity about the hip. The trochanter is not so prominent as natural, and in its normal position there is a depression. The fold of the buttock is on a lower level than on the sound side, and there is a hollow in front below the middle of Poupart's ligament. If the patient is in the erect position, the body will be bent forwards, owing to the psoas and iliacus being put on the stretch, and will be tilted over to the injured side, from obliquity of the pelvis. This

will give the appearance of very considerable lengthening, though the actual amount is very slight, and in some recorded cases no increase in length has been found after the most careful measurement. The limb is abducted and advanced in front of the other, and the toes are generally pointed straight forwards, though in some cases there may be slight eversion. The adductor muscles are stretched and form a tense cord, extending from the pubes to the middle of the thigh. The facility with which the head of the bone can be felt depends upon its position. If it rests on the obturator membrane, it cannot be distinctly felt through the muscles; but if it is displaced farther inwards and rests on the rami of the pubes and ischium, it can easily be felt in the perinæum, and sometimes even the dimple on it can be detected beneath the tense skin. A certain amount of passive motion is possible, and the patient may soon be able to perform a certain amount of flexion by his own efforts, but any attempt at extension is attended with severe pain. Patients in whom this dislocation has been allowed to remain unreduced, are often able to walk without pain, and with very little difficulty.

Treatment.—This form of dislocation can generally be reduced by manipulation. The patient is to be laid on the floor, and the surgeon, standing over him, grasps the ankle with one hand and the knee with the other, and flexes the thigh on the pelvis, at the same time slightly abducting it. He then rotates the thigh forcibly inwards, and, adducting it, brings the knee down to the floor by a movement of extension.

Another plan, which is said to answer equally well, consists in circumducting the knee inwards after flexion, until it is brought as far as the middle line of the body; then rotating outwards and extending the thigh.

A combination of extension with manipulation sometimes succeeds in reducing this dislocation. The thigh is first flexed on the abdomen, and then the head of the bone is forcibly dragged upwards and outwards into its socket, the surgeon standing over his patient and fixing the pelvis by placing his foot on the horizontal ramus of the pelvis.

Reduction by extension with pulleys must be conducted in the following manner; counter-extension is made by a girth or belt, which is to encircle the pelvis, and is fixed to a staple in the wall on the patient's sound side. Another girth is placed round the upper part of the injured thigh, and passed under the pelvic girth to prevent it slipping. To this is attached the pulleys, which are fixed to a staple in the wall on the same side as the injured limb. Extension is now made so as to pull the bone outwards and upwards, and at the same time the ankle is grasped and drawn towards the middle line of the body.

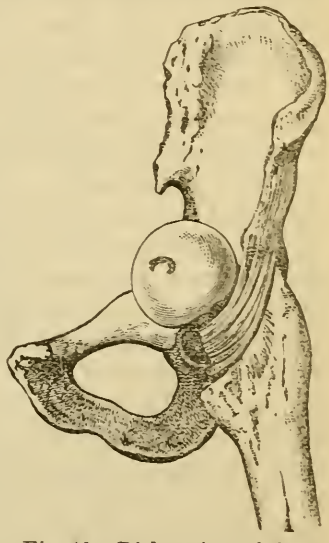

Fig. 46.—Dislocation of the Femur on to the Pubes.

Dislocation on to the pubes.—In this dislocation the position which the head of the bone assumes varies very much. Generally it is found resting on the junction of the horizontal ramus of the pubes with the ilium, but it may be placed on any part of the pubes, even as far inwards as to be in contact with its spine. Sometimes it is displaced in

front of the pubes, lying a little to the inner side of the anterior inferior spinous process of the ilium.

Symptoms.—This luxation is, perhaps, of all dislocations of the hip, the one most easy of recognition, on account of the fact that the head of the bone is generally plainly to be perceived as a rounded swelling just above Poupart's ligament. There is also considerable deformity about the hip, and a general appearance of flattening, with absence of the prominence of the trochanter. There is slight shortening of the limb, and the knee and foot are very considerably everted, and more or less abducted from the middle line of the body, and the knee cannot be approximated to the one on the opposite side of the body. There is often great pain down the front and inner side of the thigh, from stretching of the anterior crural nerve. A certain amount of flexion and outward rotation is possible, but any inward rotation or extension is impossible.

Treatment.—Reduction by manipulation should first be attempted, and will generally be found to succeed. The patient is laid flat on his back on the floor, and the thigh flexed in an abducted position, so that the knee is carried beyond the line of the side of the body. The thigh is now circumducted inwards, so that the knee is over the median line of the body. This circumduction inwards must not be carried too far, otherwise the head of the bone will be forced past the socket, and a displacement backwards be the result. The thigh is now rotated outwards and extended, so as to bring the knee down to the ground. Rotation inwards appears to succeed in some cases equally as well as rotation outwards.

Extension by pulleys must be applied as follows: the pelvis having been fixed by a perineal band fastened to the wall a little above and behind the line of the body, extension is made in a direction

downwards and outwards. After this has been done for some time, an assistant lifts the head of the bone, by means of a towel, over the brim of the acetabulum.

After reduction, in all forms of dislocation of the hip, the patient is to be kept in bed on his back with his legs tied together and the limb supported with sand-bags. At the end of about two weeks passive motion must be commenced and continued daily, great care being exercised to prevent a recurrence of the displacement. The patient must not be allowed to use his leg for some weeks longer.

Dislocation of the patella.—The patella may be dislocated outwards, inwards, or edgeways.

Dislocation outwards is far the most common displacement, and may be complete or incomplete. It is produced either by muscular contraction, by the violent action of the quadriceps extensor cruris (and hence is said to occur more frequently in knock-kneed individuals), or by direct violence, that is, a blow on the inner edge of the bone.

Symptoms.—The leg is extended, or slightly flexed and fixed in this position; the knee is flattened and broader than natural, and a depression is to be felt in the position the patella normally occupies. In the complete dislocation the bone can be felt on the outer side of the joint; in the incomplete form it presents a prominent swelling on the outer part of the articular surface of the femur, its internal border being lodged in the notch, and its external border projecting prominently under the skin.

Dislocation inwards appears to be always produced by direct blows on the outer edge of the bone. Like the former dislocation, it may be complete and incomplete, and the symptoms are much the same, with the exception that the patella is found on the inner instead of the outer side of the joint.

Treatment.—The patient having been placed under the influence of an anæsthetic, the thigh is to be acutely flexed on the pelvis, the leg at the same time being extended on the thigh. The margin of the patella which is farthest from the centre of the joint is to be forcibly depressed. This will have the effect of raising the other edge, which, being tilted over the condyles, is immediately drawn by the action of the muscles into its natural position.

Dislocation edgeways (or vertical rotation) of the patella.—In this peculiar dislocation the patella undergoes a vertical rotation around a longitudinal axis through its own centre. In consequence of this one border projects prominently under the skin, and the other is lodged in the intercondyloid notch, its surfaces being directed inwards and outwards. It occasionally happens that a complete rotation takes place, and the bone is turned completely round, so that the articular surface presents anteriorly.

This accident is generally produced by a direct blow on the edge of the patella while the limb is in a semiflexed position. It has been said also to occur from violent muscular contraction while the leg is twisted, as in jumping with the foot inverted or everted.

Symptoms.—The position of the patella at once establishes the nature of this accident; its prominent border can be felt forming a hard, well-marked ridge under the stretched skin, with a depression on either side of it. The limb is completely extended, and any attempt to flex it is attended with very great pain.

Treatment.—As a rule, reduction may be accomplished by suddenly and forcibly bending the knee while the patient is under the influence of an anæsthetic; or, should this fail, the bone may be induced to undergo a retrograde vertical rotation by pressure

on the prominent margin of the bone after the thigh has been acutely flexed on the pelvis, and in this way reduction may be effected.

After the reduction of any of the dislocations of the patella there will probably be some swelling and effusion into the joint, and the limb must be kept fixed on a splint and cold applied to the part. Passive motion must be commenced early, and the knee supported for some long period with a knee cap or bandage, since these dislocations, having once taken place, are very liable to recur.

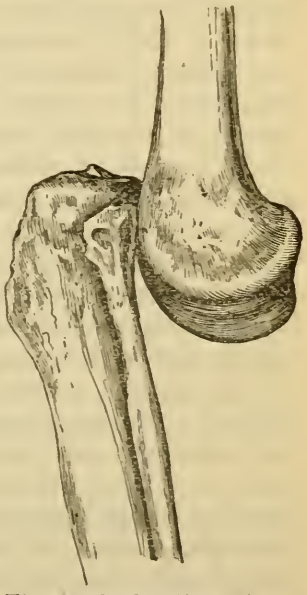

Fig. 47.—Dislocation of the Knee forwards.

Dislocation of the knee is a very rare form of injury, and is always the result of very great violence. It may occur in four principal directions: forwards, backwards, inwards, and outwards, and any of these dislocations may be complete or incomplete. As a rule, however the antero-posterior dislocations are complete; the lateral ones are incomplete.

Causes.—These injuries are generally produced by some violent strain or wrench of the knee, as in a person jumping from a carriage in rapid motion, or a fall from a horse, the foot being entangled in the stirrup, so that the patient is dragged along the ground.

In the **dislocation forwards** the displacement is usually complete, and the popliteal surface at the back of the tibia rests against the anterior surface of

the lower end of the femur. Often there is a slight lateral displacement as well. The condyles of the femur, projecting in the ham, sometimes compress or lacerate the popliteal vessels.

Symptoms.—The deformity produced is very great. There is considerable shortening; there is a projection in front of the knee, above which can generally be felt the patella, freely movable, and the quadriceps extensor is quite lax and loose. Behind the joint the condyles of the femur may be recognised by their rounded form on a lower level than the tibia in front. The limb below the knee is generally cold and swollen, and the pulsation of the tibial arteries diminished or absent. Occasionally severe pain is complained of from pressure on the popliteal nerve.

In the **dislocation backwards** the anterior surface of the upper margin of the tibia rests against the posterior surfaces of the two condyles of the femur, and the displacement is therefore not so great as in the forward dislocation.

Symptoms.—There is shortening of the limb, though not to the same extent as in the previous case, and the knee is generally semiflexed, but may be extended. The prominence of the condyles in front is well marked, and beneath them is a transverse depression. The patella can be felt resting in the groove between the two condyles. The head of the tibia is to be plainly felt in the ham, where it forms a projection among the muscles of the calf.

In the incomplete form of these antero-posterior dislocations the symptoms are the same as in the complete form, but are less marked. As a rule, in the incomplete form the popliteal vessels and nerve escape injury.

Treatment.—The reduction of these dislocations is generally easy, on account of the amount of laceration of surrounding structures which usually

accompanies the injury. The patient is to be laid on his back and steady extension and counter-extension employed, the surgeon at the same time endeavouring, by direct pressure on the displaced head of the tibia, to push it back again into its proper position. After reduction, the limb is to be maintained on a splint for two or three weeks, and cold lotions or ice applied. At the end of this time passive motion should be commenced and employed carefully and cautiously. It is advisable that the patient should wear a knee cap for some time, inasmuch as, the ligaments having been extensively torn, a recurrence is likely to result unless some artificial means of support is employed.

If the popliteal artery has been compressed by the displaced bone, the circulation in the tibial vessels will probably return after reduction has been effected. If, on the other hand, it has been lacerated, gangrene will probably supervene, rendering amputation necessary.

Lateral dislocations of the knee are more common than the antero-posterior dislocations, and are generally incomplete. The outer tuberosity of the tibia being displaced on to the inner condyle of the femur; or the inner tuberosity on to the outer condyle, according as the dislocation is inwards or outwards.

Symptoms.—The signs of this injury are well marked, and the deformity of the joint at once indicates the nature of the displacement. The prominence of the tibia on one side, with a depression above, and the condyle of the femur on the other, with a depression below, at once indicate the nature of the lesion. The limb is slightly flexed, and there is a sulcus in the situation of the ligamentum patellæ. There is no shortening.

Treatment.—Reduction is easy, and may be effected by simple extension; the surgeon at the same

time gently moving the limb from side to side, or else slightly rotating it. After reduction, the same treatment must be adopted as in the antero-posterior dislocation.

Dislocation of the semilunar fibro-cartilages.—These cartilages may be displaced in two directions, either inwards, towards the spine of the tibia, or outwards, so that they project beyond the margin of the tibia. In the first variety the circumference of the cartilage is torn away from the capsule of the joint and is turned inwards, so as to occupy the intercondyloid notch. In the second variety the cartilage is displaced away from the centre of the joint, so as to project beyond the articular surface of the tibia. There appears to be some difference of opinion as to whether the internal or external cartilage is most frequently displaced. The accident is generally caused by some sudden twist of the leg or foot while the knee is flexed. Thus a patient, while walking, may strike his toe against a stone or some inequality in the ground, and by this means displace one of the fibro-cartilages of his knee. (*See* page 256.)

Symptoms.—The patient is suddenly seized with an acute and sickening pain in the knee, often so severe as to cause him to fall. The limb is semi-flexed, and he is unable to extend it, any effort to do so being attended with increased pain. If the cartilage has been displaced away from the spine of the tibia, it may be felt projecting under the skin; but if it has been displaced inwards, it will not probably be felt, though there may be a projection on one or other side of the ligamentum patellæ, and a depression may be felt between the head of the tibia and the condyle of the femur. The injury is usually followed by rapid effusion into the joint.

Treatment.—Reduction may usually be effected by forcible flexion of the knee to its fullest extent,

and then, when the patient's attention is directed elsewhere, so that the muscles are off their guard, suddenly extending the leg on the thigh. After reduction the knee must be kept quiet on a splint, and the synovitis treated by cold. The patient should be instructed always to wear a knee cap, for the accident having once taken place is very liable to recur.

Dislocation of the head of the fibula, occasionally, though rarely, takes place. It may be dislocated forwards or backwards. When the bone is dislocated forwards its head is thrown on to the anterior surface of the outer tuberosity of the tibia; in the dislocation backwards it rests against the posterior surface of the same bone.

The head of the bone can be felt in its new position, and this, together with the alteration in the direction of the axis of the fibula, at once denotes the nature of the injury.

The head of the bone can generally be returned to its place by direct pressure, with the leg flexed, so that the biceps is relaxed. It is, however, exceedingly difficult to retain it in position, and the patient is likely to recover with some permanent deformity. This does not appear, however, to interfere much with his powers of progression.

Dislocation of the ankle.—The ankle joint, on account of its great exposure to injury, is frequently dislocated; the dislocation, in the majority of instances, being complicated by fracture. The bones of the tarsus may be displaced from the tibia and fibula in five different directions, viz. outwards, inwards, backwards, forwards, and upwards.

Dislocation outwards.—This variety of dislocation is by far the most common, and may be complete or incomplete. It is always accompanied by fracture of the fibula, and when incomplete is called "Pott's fracture"; when complete it is sometimes

known as "Dupuytren's fracture." The cause of the accident is almost always a fall on the foot, in which it is twisted outwards.

In **Pott's fracture** the fibula is first broken, usually about two or three inches from its lower extremity. The internal lateral ligament next gives way, or else, what is more common, the internal malleolus is broken off, and the astragalus becomes partially displaced from the articular surface of the tibia, undergoing a rotation on its own horizontal axis, so that the outer margin of its superior surface rests against the articular surface of the tibia.

Fig. 48.—Pott's Fracture.

Symptoms. — There is great distortion of the foot, which is twisted, so that the sole is everted. There is a marked projection under the skin, on the inner side of the foot, of the internal malleolus or its fractured extremity; and on the outer side of the leg, above the external malleolus, is a depression, where the two fractured ends of the fibula form a retiring angle with each other. (*See* page 86.)

In the **complete dislocation outwards** (Dupuytren's fracture) the trochlear surface of the astragalus is completely displaced to the outer side of the bones of the leg, and at the same time drawn upwards. The fibula is fractured. There is in these cases great increased breadth of the ankle, with

shortening of the limb. There is prominence of the internal malleolus on the inner side of the leg, and this process is sunken below its natural level. The outer malleolus, which is carried upwards with the astragalus, is prominent, and elevated above its natural level. The whole foot is rotated outwards. (*See* page 87.)

Dislocation of the foot inwards is not nearly so common as dislocation outwards, and requires greater violence to produce it. It is accompanied by fracture of the tibia, and often of the fibula also, and is caused by a twist of the foot in the opposite direction to that which produces the outward displacement. The dislocation is incomplete, and consists in a rotation of the astragalus on an antero-posterior axis, through its own centre, in the opposite direction to the outward displacement, so that the sole of the foot is inverted. The external malleolus projects on the outer side of the ankle, beneath the skin, and almost touches the ground. On the inner side of the joint there is a distinct depression corresponding to the fracture of the tibia.

Treatment.—Reduction is generally easy. The leg is to be flexed on the thigh and the toes extended, so as to relax the muscles of the calf, and extension made directly downwards, combined with slight lateral movement. If there should be any difficulty it may be advisable to divide the tendo Achillis. After reduction a pair of side splints or a junk splint is generally all that is necessary to maintain the parts in their proper position. If there is any difficulty the special treatment as recommended by Pott or Dupuytren should be adopted.

1. *Pott's method* consists in placing the patient on his injured side and flexing the leg on the thigh; an ordinary side splint, with the foot piece more thickly padded than the rest, is applied to the outer side of the leg, and a short splint reaching only to the

ankle on the inner side. The thickly-padded foot piece turns the foot inwards.

2. *Dupuytren's method* consists in applying a single side splint to the inner side of the leg; a wedge-shaped pad, with its base downwards, is inserted between the splint and the limb, its lower border corresponding to the level of the internal malleolus. The upper part of the leg and the foot are bandaged to the splint, and the foot is thus dragged inwards, and the eversion overcome.

Dislocation backwards may be complete or incomplete. In the former the trochlear surface of the astragalus is thrown behind the lower end of the tibia, which rests on the neck of the astragalus and scaphoid; in the latter the two articular surfaces do not clear each other. There is a marked appearance of shortening of the foot. In front of the ankle is a prominent transverse ridge, terminating in an abrupt margin. Behind, the heel is very prominent, and the tendo Achillis tense. The toes are pointed downwards.

Dislocation forwards is not so common as the preceding dislocation, and is generally incomplete, the anterior margin of the tibio-fibular arch resting on the summit of the articular surface of the astragalus. In these cases there is an apparent elongation of the foot; the heel is less prominent than natural; and the space in front of the tendo Achillis is filled by a hard swelling, which may be recognised as the lower ends of the tibia and fibula. The tendo Achillis is lax, and is not so prominent as in the natural condition of parts.

Treatment.—Dislocation backwards can generally be reduced with much greater facility than the forward dislocation. They are both to be reduced in the same way as the lateral dislocations, with or without division of the tendo Achillis, according to

the necessities of the case. After reduction the limb may be put up in a pair of side splints and maintained at rest for two or three weeks, when passive motion must be commenced.

Dislocation upwards.—This dislocation consists in a separation of the tibia and fibula at their lower articulation, and a forcing upwards of the astragalus between the two bones. The injury appears to be always caused by falls from a great height on to the feet; from this cause the ligaments connecting the lower end of the tibia and fibula are torn, and the force being continued, the astragalus is jammed up between them.

There is great widening of the ankle, the malleoli stand out prominently and approach the level of the sole of the foot; the relations of the astragalus are obscured, and there is an entire absence of motion in the ankle joint.

Reduction may be accomplished by forcible extension, but in some cases it has been found impossible to move the bone from the position in which it has become wedged. Recovery has, however, been said to have taken place with a fairly serviceable limb.

Dislocation of the astragalus.—The astragalus is occasionally displaced from all its articulations in a direction forwards, backwards, inwards, or outwards; or the bone may undergo a very peculiar rotation, either horizontally, so that the long axis of the bone is directed across the joint, or it may be turned on its side, so that the upper and under surfaces of the bone look inwards and outwards.

Dislocation forwards is the most common form of displacement, the bone being shot out forwards from its socket and generally undergoing a partial rotation, so that the head is inclined to one or other side. The dislocation may be complete or incomplete.

The accident is usually caused by a fall or twist of the foot while it is extended on the leg. The displaced bone forms a distinct tumour upon the instep; in front a rounded globular swelling, which under the tense and stretched skin is readily recognised as the head of the astragalus, and behind this its trochlear surface forms a projection in front of the tibia, which appears to be more or less sunken and shortened.

Dislocation backwards.—In rare instances the astragalus may be displaced backwards from all its articulations, the accident being produced by twists or strains of the foot while in a condition of flexion. In these cases the most marked sign is the presence of a hard prominence just above the heel, between the tendo Achillis and the malleoli; the foot is apparently shortened, and there is a prominence of the tibia in front.

Lateral dislocations are, if complete, always compound, and are generally, but not always, accompanied by fracture of one or the other malleolus. When the astragalus is thrown outwards the foot is displaced inwards, with great projection of the external malleolus; when the bone is displaced inwards the position of the foot is reversed.

Version of the astragalus.—This consists in a rotation of the bone either on a horizontal or vertical axis, and is produced by violent strains or twists of the foot, while it is in a position of neither extreme flexion or extension. The diagnosis of the injury is involved in considerable obscurity, and is generally to be made by negative, rather than any positive signs. Thus the history of the accident, the loss of motion at the ankle, and evident severe injury, without any marked displacement or prominence of the astragalus, may lead to a conjectural diagnosis.

Treatment.—In all the various forms of dislocation of the astragalus, an attempt must be made to effect reduction by steady traction of the foot, with the knee bent, and the patient fully under the influence of an anæsthetic. If this should fail the tendo Achillis, and any other tendon which may be felt on the stretch, should be divided, and the attempt renewed. Failing this the limb must be put up in some apparatus and the issue of the case awaited. If, as often happens, sloughing of the tense skin over the bone takes place, the astragalus should be at once removed, by an incision running parallel to the tendons. If no sloughing takes place the patient may recover with a fairly useful limb.

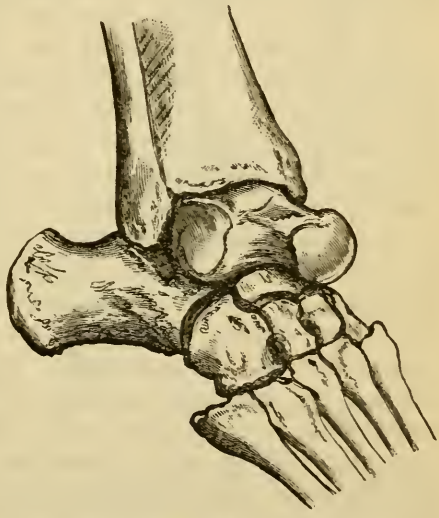

Fig. 49.—Subastragaloid Dislocation.

Subastragaloid dislocation.—This form of dislocation consists in a displacement of the rest of the bones of the tarsus from the astragalus, this bone remaining in its proper position in the tibio-fibular mortise. These dislocations are described as taking place in four directions: backwards, forwards, inwards, and outwards. Of these, the dislocation backwards is much the most common. They are generally produced by violent strains or twists of the foot, much in the same way as the other dislocations about the

astragalus; but in consequence of the greatest strain being thrown on the ligaments which connect the bone to the scaphoid and os calcis, they give way first, and the subastragaloid dislocation results, the ankle joint remaining intact.

In the dislocation **backwards** there is generally some twisting of the foot as well, so that the bones of the tarsus are displaced outwards or inwards, as well as backwards, and the head of the astragalus rests either on the outer or the inner side of the scaphoid, where it forms a globular swelling, which can readily be recognised as the head of the bone under the tightly stretched skin over it. When the bones of the tarsus are dislocated backwards and outwards, the foot is everted, so that the sole is directed more or less outwards. The inner malleolus is prominent and well marked under the skin, and the outer malleolus buried, the os calcis projecting beyond it. In the dislocation backwards and inwards the position of the foot is reversed; it is inverted, the sole looking inwards, the outer malleolus is prominent, and the inner one buried. The diagnosis of this injury from dislocation of the astragalus may be made by observing the unaltered relation of the malleoli to the astragalus, and by the recognition of the fact that there is no shortening such as takes place in complete dislocation of the astragalus, from approximation of the os calcis to the tibio-fibular arch, and that a certain amount of motion is permitted in the ankle joint.

Treatment.—There is sometimes the greatest difficulty, in these cases, in effecting reduction; this has been ascribed to various causes: to the hitching of the tibial tendons round the neck of the bone; to the sharp posterior margin of the under surface of the astragalus being lodged in the interosseous groove of the os calcis; to the under surface of the neck of the astragalus being wedged against the sharp posterior

margin of the dorsal surface of the scaphoid; and lastly, to fracture of the astragalus, the broken portion of bone preventing reduction. The manner in which extension should be made in these cases is by pulling the foot forwards, at the same time that the surgeon, by placing his knee against the front of the lower part of the tibia, presses the bones of the leg, and with them the astragalus, backwards. The tendo Achillis, or other tendons, if tense, may require division; and failing all efforts at reduction, the same treatment must be adopted in these cases as was recommended in those of dislocation of the astragalus.

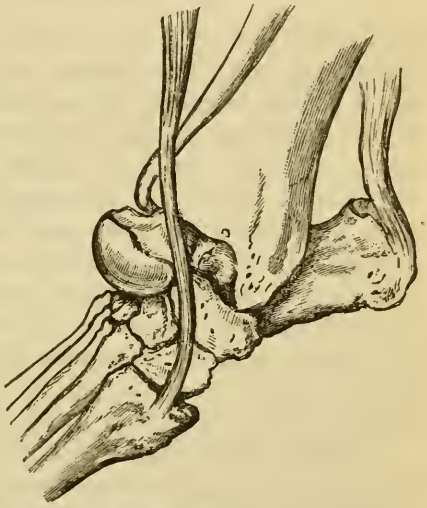

Fig. 50.—Subastragaloid Dislocation.

The other tarsal bones may occasionally be displaced from each other; one of the most common forms is the "medio-tarsal" dislocation, where the anterior tarsal bones are displaced from the calcaneum and astragalus. Or single bones may be dislocated; the os calcis, the scaphoid, or the internal cuneiform. The cuboid is said to be never displaced alone. Extension, combined with pressure on the prominent bone, will generally succeed in effecting reduction.

Dislocation of the **metatarsal bones** and **phalanges** occasionally takes place, but they present nothing of a special character either as regards their nature or treatment.

IV. DISEASES OF JOINTS.

Howard Marsh.

Synovitis.

Inflammation of the synovial membrane of the joints may occur in a variety of forms. Thus, it may be, as to its intensity, acute, subacute, or chronic; as to its products, serous or purulent; while as to its cause, it may be local when dependent on some mechanical injury or over-exertion; or general (or, as it is vaguely termed constitutional) when due to struma, rheumatism, pyæmia, etc. Although acute and chronic synovitis merge insensibly into each other, through the various grades of the subacute form, they yet, when typical examples are selected, present a strong contrast, alike in respect to their morbid anatomy, their symptoms, and their results.

Acute synovitis.—For the purposes of description it will be convenient to select an instance in which the affection has been produced by local injury such as a severe wrench. The changes that take place are in all respects analogous to those met with in inflammation of any of the connective tissues. The membrane becomes vividly injected with blood, so that its surface presents a bright red appearance, involving especially the various folds and processes, whose colour forms a striking contrast with the pearly whiteness of the articular cartilage; while here and there are to be seen minute petechial specks, or larger extravasations of blood which has escaped from over-distended vessels. Becoming rapidly loaded with exudation products, the membrane is rendered velvety and succulent, and so swollen that it overlaps and obscures the borders of

the articular cartilage, and lies closely packed in all the recesses of the joint. At the same time, the synovial fluid rapidly increases in quantity, and becomes charged with inflammatory products, so that the articular cavity becomes distended. The fluid is at first clear, but is afterwards mixed with leucocytes and flakes of fibrine which give it a cloudy appearance; and commonly also with a small admixture of extravasated blood. Having advanced to this stage, when all its characteristic features as an acute inflammation have been developed, synovitis, under the influence of treatment, may subside, and undergo resolution; cell proliferation ceases, exudation products are absorbed, the blood-vessels regain their normal calibre, and the membrane recovers its natural appearance. In other cases, however, which from the first are more severe, or in which appropriate treatment is not brought to bear, the synovial fluid is rendered turbid and milky by cell exudation, and is soon converted into completely formed pus. Should pus thus resulting be evacuated early, under safeguards against septic infection, repair may occur, and the membrane gradually return, in part or altogether, to its normal condition. In many instances, however, an acute purulent synovitis passes on to destructive changes, involving the membrane itself, the ligaments, and articular cartilages, and even to some extent the ends of the bones forming the joint, so that a general arthritis is established (page 235).

In *subacute synovitis*, changes similar to those described as occurring in the early stage of the acute form are met with. They are, however, less marked, and of lower intensity.

In **chronic synovitis**, whether (*a*) primary and induced by some local cause too mild in its action to excite acute inflammation, or (*b*) remaining after acute inflammation has subsided, the synovial membrane is

unduly vascular (often rather from venous congestion than from active arterial injection, such as is present in the acute form), swollen, and succulent, and loaded with exudation products, which, as the case proceeds, may either undergo development into fibrous tissue, so that the membrane becomes thickened and indurated, or pass into a state of fatty or "pulpy" degeneration. The amount of fluid in the articular cavity may be but little increased; but generally it is in considerable excess, so that the synovial membrane is distended. The fluid is largely diluted with serum, and often highly albuminous, but as it contains few exudation cells, or flakes of fibrine, it is either only slightly opalescent, or remains quite clear. Although often prolonged over considerable periods, chronic synovitis usually at length undergoes resolution, and the changes above described are slowly repaired; fluid is absorbed, swelling subsides, and the tissues return to their normal degree of vascularity.

The **symptoms** of *acute synovitis* are pain, of a tense, bursting, or burning character, worse at night, and aggravated by the slightest movement of the joint, but generally not associated with those spasmodic startings of the limb which occur when the deeper structures are affected; swelling, which, as it is due mainly to effusion into, and as it takes the shape of, the synovial membrane, is very characteristic; in very acute cases swelling is due in part also to effusion into the soft structures around the joint; heat detected when the hand is lightly placed on the surface, tenderness on pressure, and in severe cases, a faint surface blush. The joint is somewhat flexed, and is kept in the position of greatest ease, so that the capsule and ligamentous structures are relaxed. Muscular atrophy, detected on measurement, is generally present early in the case, and sometimes is well marked even in a few days. These various

symptoms, after persisting for a time, may gradually subside, and recovery may take place, the usual result when appropriate treatment has been adopted. The affection, however, is very apt to be prolonged into the chronic stage.

Treatment.—The first step in the treatment of *acute synovitis* must always consist in placing the articulation at complete rest. This, in the joints of the upper extremity, is effected by means of well-fitting splints; while, when the joints of the lower extremity are involved, not only must splints be used, but the patient must be confined to the horizontal posture. The position of the joint is a matter of great importance. It must be borne in mind that the attack may, through the formation of adhesions, leave the articulation fixed; and also that, as the result of softening of the ligaments, and reflex spasm of some of the surrounding muscles, there is a marked tendency, especially in the hip and knee, to the production of deformity. The joint must, therefore, be very gently brought into a position in which, should it be left stiff, it may still be useful. To effect this, and while splints are being applied, an anæsthetic may, particularly in children, be used with advantage, both to produce muscular relaxation and to save pain. Subsequently care must be taken that no deformity is allowed to occur. Other means to be adopted vary with the case. At the present day leeches are seldom employed, nor are they often required; yet when the inflammatory process is very acute, and sudden in its onset in strong adults, the application of eight or ten leeches has a very markedly beneficial result. Much relief also is obtained by cold evaporating lotions, the application of an ice bag, or by irrigation with iced water. Should the synovial cavity become rapidly distended, the fluid may be drawn off with the aspirator, the utmost care being taken to avoid

the entrance of septic matter. The removal even of three or four drachms from the knee joint will often give great and permanent relief. Should the case be seen at its very commencement, or in the first few hours after the attack has set in, the inflammatory process may sometimes be checked by the application of a Martin's indiarubber bandage, which should, however, not be put on tightly. This method is appropriate in instances in which synovitis has been produced by a sprain, or wrench, particularly in such joints as the ankle and the elbow.

Adequately treated, acute synovitis usually subsides in the course of from three to eight or ten days, and recovery gradually takes place. In some instances, however, the affection runs on to suppuration; a result indicated by an increase of pain and swelling, the appearance of a distinct blush on the surface, and the presence of œdema of the soft parts around the joint; by rise of temperature to 101° to 104°, often by the occurrence of a rigor; and by an increase of the symptoms of general illness, the patient being restless, and unable to sleep or take food, and showing rapid loss of flesh and strength. The treatment necessary under these circumstances is that laid down for acute arthritis (page 237).

Subacute and chronic synovitis.—As in the acute form, the joint must be kept at complete rest. Small blisters are often useful. They should be applied in a series of three or four; one healing before the next is put on. In tedious cases the blistering may be continued for three or four weeks, or may be superseded in adults by the application of the benzoline cautery. If the joint still contains fluid, or if thickening of the synovial membrane remains, uniform pressure by means of the indiarubber bandage, carefully adjusted twice or three times a day, should be used. Under this application swelling will often completely disappear in the course of a very few days.

Should this plan fail, the joint may be covered with the unguentum hydrargyri or the unguentum hydrargyri compositum spread on lint, and over this the elastic bandage may be adjusted. Rest must be maintained as long as there is heat or pain in the joint; or while either of these symptoms or any increase of stiffness is produced by tentative exercise. Later, the joint may be douched with hot salt water and rubbed with stimulating liniments, and passive movements (provided they do not produce swelling, heat, or stiffness, that does not quickly subside) may be used. In some instances the joint remains distended with a large quantity of fluid, constituting one of the forms of hydrops articuli. The treatment of this condition is described at page 233.

Rheumatic synovitis.—The morbid anatomy of rheumatic synovitis corresponds closely with that of simple synovitis of a like grade of severity. The inflammatory process, however, often extends more widely, and involves the subsynovial and periarticular tissues. The cartilages, in severe cases, are swollen or even eroded, and the ligaments are inflamed and softened. Suppuration, though it is very rare, does occasionally take place. The characters of the synovial fluid vary with the intensity of the case. Generally, it resembles that of simple synovitis, except that it is more rich in fibrine. Rheumatic synovitis usually ends in resolution in the course of from three or four days to a fortnight. Not rarely, however, when inflammation has extended to the ligaments and periarticular tissues much stiffness may remain; or even a true fibrous ankylosis may take place, rendering the joint permanently fixed. In the subacute and chronic forms of the disease the tendency is towards the organisation of the inflammatory products, and it is to the contraction of this newly-formed fibrous tissue in the thickened capsular and other ligaments, and in the

periarticular tissues, that the stiffness of the joint so frequently met with is due.

Symptoms.—Acute articular rheumatism is characterised mainly by the suddenness of its onset and the severity of the local symptoms The joint becomes rapidly swollen from effusion into the synovial cavity and perisynovial tissues. The surface temperature is raised to 100° or 104°; the skin over the joint is exquisitely sensitive, and often presents a distinct flush, and movement is extremely painful. There is, however, in the condition of the joint itself, nothing conclusive as to the nature of the case.

Diagnosis turns on collateral circumstances: the absence of injury; the sudden development of the affection after a chill; the history of previous attacks of a similar character; the presence of acid sweats; the coincident occurrence of rheumatism in other parts: while should any doubt at first exist, this is often soon cleared up by the appearance of the disease in some other joint.

Acute rheumatism differs from *acute gout* in the fact that it may occur at any age after early infancy, whereas gout is most common between forty and sixty; that in gout the symptoms, especially the pain, are more intermittent or paroxysmal, often entirely disappearing during the day, and returning with agonising intensity during the night; in gout, too, the joint is much more red and sensitive, and the pain much more violent. In gout the general health is little disturbed, and the pulse and temperature are but little above the normal. In the majority of instances the first attack of gout affects the great toe, while in subsequent attacks the history that the great toe joint has been involved may be taken as a strong presumption as to the gouty nature of the affection. The presence of deposits of urate of soda either in the ears or the finger joints will also be highly important evidence of gout. while the

examination of the blood for uric acid would, if it were thought advisable, still further assist in diagnosis.

Treatment.—Much of the suffering attending acute rheumatism is due to the dragging weight of the limb, and great relief is often afforded by supporting the joint upon a splint. A splint is also advisable, since it keeps the joint in a satisfactory position and prevents deformity (to which there is sometimes a strong tendency in cases in which the ligaments are inflamed and softened), which might subsequently lead to serious results. The joint should be covered with lint soaked in belladonna liniment or lead and opium lotion ; or be sprinkled over with a solution of atropine and morphia, and wrapped in cotton wool. The plan of freely blistering the joint, as advised by Dr. Herbert Davies, sometimes gives speedy relief. Experience, no doubt, shows that the aspiration of a joint that has suddenly become tensely distended gives great relief, but the operation cannot be said to be free from risk, and cannot be regarded as desirable in these cases. Should the extremely rare event of suppuration occur the case must be treated as described at page 237. In severe attacks affecting the knee and the wrist, there is a formidable tendency, as the result of softening of the ligaments and reflex muscular spasm, to displacement and distortion. Should this result be threatened, no time should be lost in supporting the joint by the application of efficient splints.

Chronic rheumatic synovitis.—In this condition (often left after the acute form has subsided) the affected joint remains enlarged, tender on pressure, painful on movement or when the part is warm in bed, and so stiff and weak that the patient cannot lift any object, or bear any weight on the limb. Usually several joints are affected ; the knee, shoulder, and the small joints of the fingers are most often, the hip,

perhaps, the most seldom attacked. The affection is very erratic, often changing from joint to joint, and varying in its severity with the weather, temperature, degree of damp, etc., and especially with the patient's general health. The disease may last for many weeks or even months, while in some cases the joints are left permanently weak, stiff, and painful. In some cases the disease assumes, from the first, a chronic and insidious form, attended with pain, weakness, and stiffness, and with creaking and grating; and goes on to changes involving the cartilages and articular ends of the bones, the former becoming fibrillated and worn away; the latter eburnated and "lipped" at their articular margins. In a third group so much effusion occurs into the synovial cavity as to constitute one of the varieties of hydrops articuli (page 232).

Treatment.—Rheumatic subjects should wear flannel underclothing in warm as well as in cold weather, so that a uniform temperature of the surface is maintained, and any joint that is affected should be enclosed with a woollen knee cap or similar covering. Though fatigue must be avoided, the patient should be advised to keep the joint in gentle exercise (except during sharp attacks), for a fixed condition of the articulation certainly increases the tendency to stiffness. It is a good plan to direct the patient to practise the carrying of the limb through its full range of movement, or to have gentle passive movement regularly performed. Local treatment consists in douching and bathing the joint with the hottest water that can be borne without pain, and in the use of the hot vapour bath and of shampooing. For the management of cases in which the joint is distended with fluid *see* page 233.

When joints are the seat of long-standing rheumatism, relief is often obtained by strapping with soap plaister or the emplastrum ammoniaci cum hydrargyro. The continuous electric current, in a mild form, is

sometimes very useful, both in the relief of pain and in arresting atrophy of the surrounding muscles.

General treatment comprises the use of alkalies (bicarbonate or citrate of potash), with bark or some bitter tonic, if the patient is in weak health. In anæmic cases, quinine and iron should be given.

Potassium iodide, in small doses, combined with an alkali, is often beneficial. Free excretion, both by the bowels and kidneys, should be promoted by the use of aperient mineral waters (of which, probably, the Hunyàdi János is the best), and of diluent drinks. A damp climate should be avoided. Great benefit is obtained from residence at such of the health resorts as are placed at a considerable level above the sea, and at which hot baths, douching, and shampooing, can be obtained. The most suitable are Buxton and Harrogate in England; and, on the Continent, Aix-les-Bains, Baden, and Wildbad.

Gout.—Gout is a constitutional affection, one of the main lesions of which consists of an inflammation of the joints, associated with the deposit of urate of soda. The morbid anatomy of the disease, so far as it involves the joints, is briefly the following:

During an acute attack the synovial membrane presents the appearances met with in simple acute synovitis, as to increased vascularity and swelling; while the fluid is increased in quantity, and rendered turbid by cell exudation. The articular cartilages become inflamed, and microscopic examination shows abundant cell proliferation, and a tendency to fibrillation of the matrix; while both on the surface and in the substance of the cartilage, especially in the central or deeper parts, a white deposit of urate of soda takes place.

In cases of long standing the cartilage is eroded and worn away, and the articular ends of the bones are more or less exposed. These, as the disease advances,

become invaded with the deposit of urate of soda, and the seat of chronic inflammatory changes. A similar deposit, followed by inflammation, progresses in the synovial membrane, ligaments, and in the peri-articular structures. Ankylosis, though it is very rare, occasionally takes place. Much more commonly, however, loss of movement is due to alteration in the shape of the articular ends of the bones, and to degenerative changes involving the synovial membrane, ligaments, and other soft structures, in and around the joint. Most pathologists hold that the phenomena of gout are originally due to an increase in the amount of uric acid in the blood; and it is believed, so far as the joints are concerned, that this substance is deposited, in combination with soda, in the form of the urate, and, by its presence in the tissues, induces the inflammatory outbreaks observed in this affection.

Symptoms.—Gout attacks the joints in two main forms, the acute and the chronic, connected with each other by numerous intervening gradations. In a typical example of the acute form, a patient who has gone to bed in apparently good health is awoke with sharp pain in the metatarso-phalangeal joint of the great toe. He feels chilly, or even has a distinct shivering fit succeeded by free perspiration. Pain, which is of a boring or wrenching character, increases till it reaches an unbearable intensity. The toe is swollen and stiff, and the skin exquisitely sensitive and bright red, and marked with distended veins. The surface pits on pressure, and œdema extends for some distance over the adjacent part of the foot. Towards morning swelling increases, and pain becomes less intense; and the day is passed in comparative ease. During the following night, however, all the symptoms return, with even more than their former severity, and the patient is feverish, restless, and distressed; but in a few hours perspiration comes on and he is able

to sleep; and on waking he finds that the swelling, redness, and other symptoms have to a great extent disappeared. These characteristic exacerbations by night and remissions during the day continue for three or four days, and then the affection subsides, and is followed by desquamation of the skin, and often by very troublesome itching. Suppuration has been met with, but is extremely rare. The ball of the great toe is, in a large proportion of instances of typical gout, the first joint to suffer; but this is not always the case, and either the knee, elbow, wrist, or the small finger joints may be the seat of the original attack. Frequently, as gout subsides in one joint, it appears in the corresponding joint of the opposite limb. All the articulations, including those of the fingers and toes, are liable to be affected, but the shoulder and hip usually escape.

In weakly and anæmic persons, especially in women, gout occurs in a less violent form, and all the symptoms mentioned above are subacute. The affection is often very persistent, and leaves the joints in a very weak and crippled condition. Complete ankylosis, though rare, is occasionally met with. An attack of gout may be induced by a variety of causes; by erroneous diet, particularly by the free use of malt liquors or wine, especially where the different kinds are mixed; excessive fatigue, mental anxiety or excitement, external injury, such as a fall or even a slight sprain, or a surgical operation; I have seen it follow vaccination performed on a patient who was a little over fifty years of age. When the acute merges into the chronic form the seizures grow less acute but more prolonged, and of more frequent occurrence; and involve a larger number of joints, which become weak, stiff, painful, and distorted, and not rarely, particularly the joints of the hand, the seats of deposits of urate of soda forming 'tophi' or chalk stones. When these are large they often produce suppuration, leading to ulceration of the

skin and the prolonged discharge of sanious pus, loaded with urates in the form of chalky material. In some instances several of these abscesses form in the same hand, and, though causing little disturbance, remain open for many months. In chronic gout the general health is much impaired, and the patient becomes pale, thin, and cachectic.

Diagnosis.—As special remedies are called for it is a matter of great importance to recognise gout without delay when it attacks the joints. The following are the main points to take into consideration. The question whether the disease has occurred in other members of the family, or whether the patient has already suffered from the disease. The patient's age. Gout is very rare before puberty, and does not usually occur before thirty or forty; but after this period it is common up to very old age. The disease is more common in men than in women. In women it most commonly occurs after menstruation has ceased. The habits of the patient as to diet often suggest the probability of gout. Gouty persons are often markedly dyspeptic, and unable to digest either malt liquors or wine. The character of the attack itself must be considered. When a joint, especially if it be the great toe joint in a middle-aged or old person, becomes, apart from injury, suddenly during the night extremely painful and tender, and when the skin over the joint is bright red and œdematous, gout may be strongly suspected. In gout the body temperature is but little raised, and the patient's general health but little disturbed; while in acute rheumatism and pyæmia (the affections which locally present the strongest resemblance to gout) the temperature is high and constitutional disturbance considerable. In gout, also, remissions by day and exacerbations by night are distinctly marked. Gouty deposits of urate of soda should be looked for in the

finger joints, the ears, and in any enlarged bursæ that may be present. For a full list of the minor signs of gout the student should consult Sir James Paget's valuable and graphic article in his volume of "Clinical Lectures and Essays." Chronic gout may usually be recognised by the patient's history of previous acute attacks involving the great toe; the frequent presence of uric acid in the urine, the sudden onset and equally sudden cessation of the attack, the nocturnal exacerbations, and the presence of deposits of urate of soda in the situations already mentioned. The urine should always be examined for albumen, which is often present in chronic gout.

Treatment.—This must be local and general. The joint must be supported in a position favouring the relief of congestion. When any joint of the lower extremity is attacked the limb must be kept in the horizontal posture; the elbow, wrist, or hand must be kept in a sling. Though, in so acute an inflammatory process, leeches seem indicated, all authorities, including Dr. Garrod, oppose their use, on the ground that local depletion seems to favour the deposit of urate of soda and the production of stiffness or even of ankylosis. The joint should be wrapped in a layer of cotton wool, covered with oil-silk; or a lotion consisting of one grain of atropine, eight of morphia, and two drachms of spirits of wine in an ounce of water may be applied on lint under oil-silk; or a lotion of lead and opium may be used in a similar manner. General treatment should commence with an aperient. Colchicum exerts a powerful, often almost magical influence upon gout, yet the drug so often, especially in weakly persons, produces sickness, purging, and general prostration, that it must be cautiously given. It is most efficacious in the acute gout of the strong and full-blooded; but it also often gives relief in chronic gout; and some patients who are weakly and broken down in general health

not only tolerate the drug, but derive signal benefit from its use. It should therefore be prescribed in the acute forms of gout; and also cautiously in chronic gout should other drugs fail to give relief. An alkali, in the form of the bicarbonate or citrate of potash, should be given to correct acidity in the urine. Lithia derives its value in gout from the fact that urate of lithia is a more soluble salt than that of either potash or soda. The citrate or the carbonate should be given, in doses of four or five grains, in potash water; or, in combination with twenty grains of citrate of potash, in a tumbler of water twice or three times a day. In chronic gout much benefit is obtained by a course of treatment at the health resorts mentioned on page 219. For anæmic patients bark or quinine should be prescribed, in combination with the directions already mentioned.

Syphilis.—Affections of the joints are among the rarest manifestations of syphilis. Yet it is probable that they are more common than has hitherto been supposed. They may be met with at any period, both in the secondary and tertiary stages, and also in the inherited form of the disease. (*See* page 250, vol. i.)

1. In the secondary stage, during the prevalence of skin eruptions, ulcers of the tonsils, plastic iritis, etc., one or more of the joints (most usually a single articulation, and that either the knee or the elbow) may be the seat of an affection consisting of gummatous infiltration of the subsynovial tissue and effusion into the synovial cavity. In these cases thickening of the periarticular tissues in the form of ill-defined indurations, or sometimes of distinct nodular deposits, may sometimes be detected. In their general character, however, these affections present little to distinguish them from ordinary chronic synovitis, and their true nature is suggested only by their origin apart from the common causes of synovitis,

and the fact that the subjects of them have had, or are still suffering from, other forms of syphilitic disease. Their main features are their persistency, and their strong tendency to relapse. Pain, heat, and stiffness are usually but little marked. A woman, the subject of secondary syphilis, was lately seen at St. Bartholomew's Hospital, in whom synovitis of the elbow joint with effusion disappeared under the use of iodide of potassium three times, but at once relapsed as soon as the iodide was discontinued. Ultimately, however, complete recovery took place.

2. In other instances, in the tertiary period, the disease consists of an osteitis and periostitis of the articular end of one of the bones forming the joint, leading to the formation of node-like outgrowths similar to those met with in other examples of syphilitic osteitis, and accompanied with gummatous infiltration of the synovial membrane and effusion into the cavity of the joint.

3. In some instances, again, though rarely, the joint is involved by the breaking down of a large gumma in the subcutaneous tissue, and the subsequent ulceration attending the process. In one case the knee joint was involved in the course of syphilitic necrosis of the patella. Some of the most obstinate examples of syphilitic affections of the joints are those in which the disease is combined with chronic gout, rheumatism, or osteo-arthritis. In infants syphilis takes its origin as a subacute inflammation involving the line of junction of the epiphysis with the shaft. Here, as the inflammatory process advances, a soft granulation tissue is formed, and ulceration ensues, with the result that the epiphysis often becomes detached from the shaft; caries may extend so as to involve the bone for some distance. In many cases no matter forms, and the joints themselves escape; but in other instances suppuration occurs, the structure of the

epiphysis is broken down, and the articular cavity is involved in the extension of the disease.

The *diagnosis* of these cases may be attended with considerable difficulty. A joint affection, however, may well be suspected to be syphilitic when it occurs apart from local injury in a person who gives no history of gout or rheumatism, but who has had syphilis; and when ordinary forms of treatment fail; when other syphilitic lesions are present; and when the irregular thickening or nodular swelling of the synovial membrane and periarticular structures resembles gummatous infiltration of these tissues rather than any of the usual forms of chronic inflammation. In some cases nocturnal pains, depending on osteitis and periostitis, are well marked.

Treatment consists in the use of splints to maintain the joints at rest, and the administration of iodide of potassium. In obstinate cases the iodide salt should be combined with the liquor hydrargyri perchloridi, and the joint should be strapped with mercurial ointment and soap plaister, or a liniment of the oleate of mercury may be rubbed in. The disease is very obstinate and very prone to relapse; treatment must, therefore, be persistently carried out, and must include the remedies for chronic gout or rheumatism, when these affections are present.

Pyæmia, and other acute specific diseases.—A general group of cases of synovitis is formed by those examples which are developed in the course of pyæmia, puerperal and scarlet fever, gonorrhœa, variola, typhoid, dysentery, and some other conditions. In all alike the affection results from the presence in the blood of some septic material derived from the primary disease; and in all alike the process at work, though not, perhaps, identical with, is analogous to and well illustrated by that observed in pyæmia. In their general clinical characters these various forms of

synovitis strongly resemble each other, though they present considerable differences in their severity, the structural changes to which they give rise, and the subsequent condition of the joints in which they have had their seat.

Pyæmia.—In pyæmia the joints may be attacked at any period of the disease, which, it must be remembered, though often acute, is sometimes chronic, and prolonged over many months. In acute cases, often the first symptom of blood poisoning is synovitis of the shoulder, the knee, or some other joint, and soon other articulations are involved. (*See* page 148, vol. i.)

In the worst cases several joints are attacked in rapid succession. In these instances the synovial membrane is acutely inflamed, and the joint rapidly becomes distended with flaky pus, often mixed with blood, giving it a red or grumous appearance; and the membrane itself, the ligaments, and the cartilages undergo destructive changes; the skin becomes red, shining, and perhaps œdematous, and the joint within three or four days becomes completely disorganised, the capsule bursts, and the surrounding soft parts become widely involved. In less severe examples the inflammation is subacute, and the synovial cavity is distended with pus, so that its outline is marked out by a flaccid swelling, in which fluctuation is extremely obvious; the skin, however, is unaltered, and there is so little heat or pain that the patient makes no complaint of the joint, the condition of which may be easily overlooked, or be only accidentally discovered; while on post-mortem examination little swelling or redness of the membrane is to be observed; and the ligaments and the cartilage present no obvious change. In some cases, again, synovitis is acute and plastic, and is followed by firm fibrous, or bony ankylosis; while in others, large readily fluctuating collections, not involving the joint itself, form in the periarticular tissue,

yet without redness or other signs of acute inflammation. It is remarkable that in some examples of pyæmia the local manifestations are entirely confined to the joints, while in other instances the joints entirely escape.

Prognosis.—In cases in which the patients survive, and repair takes place, the effusion may be slowly absorbed, and the joint may regain free movement. In the majority of instances, however, there is considerable stiffness, often firm, fibrous, or bony anchylosis, frequently associated with serious distortion.

Treatment.—In consequence, in the less acute cases, of the large amount of effusion which takes place, and which is associated with relaxation of the ligaments, and, in acute cases, in consequence of the rapid disorganisation of the joint, there is a strong tendency to the displacement of the articular ends of the bones. This is especially the case in the knee and wrist. Moreover, the joint is frequently the seat of excessive pain, aggravated by movement. It is essential, therefore, that the limb should, from the first, be carefully supported on a splint. When the disease is acute and attended with suppuration, matter should be at once evacuated under strict antiseptic precautions, and free drainage should be provided. When effusion is more passive, and there is no pain or redness of the skin, the fluid may be drawn off with the aspirator. The removal of fluid is advisable. With care the operation may be safely conducted, while, if fluid is left, the fibrine remaining after its more liquid parts have been absorbed will lead to the formation of adhesions and the development of ankylosis.

In cases in which joints have become disorganised, amputation may, should the patient survive, become necessary. The operation must generally, however, be delayed till the active stage of septic infection has

passed, and the temperature is no longer high or widely fluctuating.

In **scarlet fever** synovitis resembles that met with in pyæmia in being sometimes acute, and leading to rapid disorganisation of the joint, by extension of the inflammation to the deeper structures, and sometimes subacute or chronic; in affecting one or several joints; and in its general course, and termination. The treatment is the same as that of synovitis, depending on pyæmia. The same may be said of synovitis occurring in the **puerperal state.** The joint affection is essentially pyæmic in its character. Often the knee is the only joint affected, and the inflammatory process is throughout subacute. The mischief, however, soon spreads to the deeper structures, is very persistent, is accompanied with severe pain, and tends to induce deformity and to terminate in fibrous ankylosis. In some instances many joints are involved, and the case runs the usual course of an acute pyæmia.

Gonorrhœal or urethral synovitis. — It is now well known that not only gonorrhœa, but also simple purulent urethritis, such *e.g.* as sometimes occurs after the use of catheters, may give rise to synovitis. In this affection, for which urethral synovitis or arthritis is a better name than either gonorrhœal synovitis or the old term gonorrhœal rheumatism, usually one joint, and that a large one, is attacked. The knee is most often affected, but the hip, the ankle, and the wrist are not rarely attacked, while a very troublesome form is that which involves the ankle and the contiguous tarsal joints and the fibrous structures in the sole, with the result of inducing a very aggravated form of flat foot. The disease, though sometimes acute, and passing on to suppuration, or even to complete disorganisation of the joint requiring amputation, is for the most part subacute (often it is very chronic)

and characterised rather by plastic exudation than by copious effusion. The ligaments and the periarticular structures are involved in the inflammatory process, and the tendency to the formation of new fibrous tissue is strongly marked. Bony ankylosis, though it is rare, may occur. The attack may be preceded by an increase of the urethral discharge. Often, however, the amount of discharge is unaltered by the onset of the joint disease; while sometimes discharge is considerably diminished. The disease, attended by pain, heat, and moderate swelling, often persists in a form much resembling subacute or chronic rheumatism, now subsiding, and presently returning with increased intensity for many weeks or months, and at length leaving the joint permanently stiff. It is not rarely symmetrical. In those cases in which several of the larger joints are attacked (*e.g.* both the knees and both the hips, or the ankles and the knees) the patient may be left completely crippled. Even the joints of the spine may be affected, and cases are on record in which in the course of different attacks every large joint has become fixed. The affection is very rare; *i.e.* its percentage among cases of gonorrhœa is very small. Sometimes the affection is ushered in by slight fever and a sense of chilliness, or the occurrence of a distinct rigor. In other instances the premonitory symptoms are absent, and the first sign is that one of the joints is hot, tender, painful, and swollen, as in subacute rheumatism. A notable fact respecting the affection is that in some individuals it is repeated with every attack of gonorrhœa. Urethral synovitis, though occasionally met with, is very rare in the female sex. A correct diagnosis is very important, and here, as in so many other cases, it is readily made if the mind of the surgeon is on the alert. In any case in which arthritis, simulating subacute rheumatism, especially when monarticular, occurs in a person who has never

had rheumatism, and when the attack tends to be prolonged and persistent, the question of the presence of urethral discharge ought to be inquired into.

Treatment must be addressed: (*a*) To the arrest of the urethral discharge. (*b*) To the local management of the joint attack. The treatment of the urethral discharge must vary with the gonorrhœal or other origin of the affection, the stage it has reached, the amount and character of the urethral secretion. (For directions on these points *see* Art. XXIII., vol. i.) The joint should be placed at rest. When heat and other symptoms have subsided under the use of cold applications, a course of small blisters (one healing before the next is applied) should be prescribed, and the joint may then be covered with mercurial ointment spread on lint, and over this an elastic rubber bandage may be adjusted; or the part may be strapped with soap plaister. Iodide of potassium is often useful in five-grain doses in the after stages of the disease. Iron tonics will be called for if the patient is anæmic and weakly. If he is gouty, lithia or colchicum should be used. (*See* under Gout.) Motion may sometimes be restored by movement of the joint under an anæsthetic, followed by daily passive movement, hot douching, and shampooing.

In the course and after the subsidence of **typhoid fever**, and less frequently of **variola**, one or more of the joints may be attacked either with a subacute synovitis (this is the most common form), or with a plastic inflammation involving also the ligaments and the cartilages, or very rarely by an acute suppurative arthritis. The joint most frequently attacked, at least in typhoid, is the hip, but other joints occasionally suffer. There is developed synovitis, rapidly leading to effusion, distension of the capsule, and often to spontaneous dislocation, an occurrence that is sometimes unfortunately overlooked

till the patient is convalescent from his fever. The plastic form of arthritis is usually subacute and attended with considerable pain. It leaves the joint stiff, or in severe cases completely ankylosed, and this often, where treatment has not been applied, in a very inconvenient position. Suppurative arthritis, happily very rare in connection with the exanthemata, presents the general features, and requires the treatment described at page 237.

HYDROPS ARTICULI.

Hydrarthrosis, hydrarthrus.—In this affection, often vaguely spoken of as dropsy of the joints, the synovial cavity becomes distended with a chronic serous or watery effusion. The condition is produced in several ways. It may remain after acute synovitis has subsided; or it may arise in the course of chronic synovitis, especially when this is of rheumatic origin; or it may be developed apart from any of the usual signs of inflammation, in the form apparently of a mere passive exudation, much resembling the simpler forms of hydrocele of the tunica vaginalis. The morbid anatomy of the first two varieties is the same as that of chronic synovitis. In the third form, which, however, is rare, the synovial membrane is anæmic and pale, or presents a white or yellowish, macerated appearance. In cases of long standing, the membrane itself and its subserous layer become thickened by new fibrous tissue; and its processes and fringes undergo hypertrophy, present numerous tufts and pedunculated growths, and often contain nodules of cartilage.

In some cases the major part of even a large swelling of the joint is due to the close packing of these synovial fringes, and the quantity of fluid present is very small. As time goes on the ligaments become elongated, and displacement occurs; or the

joint is loose, weak, and insecure when weight is thrown upon it. In many cases large bursal collections are formed in the neighbourhood of the joint. The fluid of hydrops articuli (which may amount to as much as three pints or even more) is a thin, often turbid, form of synovia, containing in many instances flakes and fibrinous shreds. The affection is most common in the knee. It may be limited to one knee joint, but often both are ultimately attacked. It occurs also in the shoulder and elbow, and, though very rarely, also in the other joints. Often single, it seldom involves more than two joints in the same patient.

Symptoms.—The knee joint, which may be taken as the best example, is largely distended, cool and painless, but weak, and its movements are embarrassed. Fluctuation is very obvious. The patella, unless distension is too great, can be pressed down so that it strikes the femur. The synovial membrane, in old cases, is thickened; and indurated folds and fringes, or even masses of cartilage, can be felt. The bursa under the semimembranosus muscle in the ham is often enlarged, and may extend for some distance down the calf. The patient cannot walk far, and finds going upstairs a great difficulty. The disease is most common in men between thirty and sixty, but it may be met with in females, and at any age after puberty.

Treatment.—In the early stage, especially when hydrarthrosis is of inflammatory origin, the joint must be kept at complete rest by means of firm leather or other splints, cut away so that there is space for blistering. A succession of blisters, one and a half to two and a half inches square, should be applied at intervals of four or five days, or as they severally heal; or counter-irritation may be produced, either by iodine paint, or by rubbing in the unguentum hydrargyri biniodidi over a space of two or three square inches. After the blistering (continued for

three or four weeks) the joint should be compressed by a carefully applied indiarubber bandage, under which may be placed lint spread with mercurial ointment or with oleate of mercury; or the joint may be aspirated and the treatment by elastic pressure be continued. When all these means fail (and it must be confessed this is often the case), the method has been recommended, and occasionally practised, of removing part of the collection with a trocar and canula, and injecting the synovial cavity with a solution of tincture of iodine in two or three parts of water. Though it sounds formidable, this proceeding, carefully employed, seems to involve very little danger. Its success, however, is very doubtful; for though it produces considerable inflammatory effusion, similar to that following the injection of a hydrocele, the fluid often soon re-accumulates, and the disease continues to progress. As an ultimate step, provided the patient is under thirty and in sound general health, the joint (antiseptic precautions being strictly carried out) may be opened by two free lateral incisions and the fluid evacuated; drainage tubes, or, better, strips of guttapercha tissue, should then be introduced, and retained for two or three weeks while shrinking of the synovial cavity is taking place. In a case of hydrops articuli of rheumatic origin, in a man aged twenty-six, Mr. Willett, at St. Bartholomew's Hospital, opened the knee joint, scraped the synovial membrane, and washed out the joint with a solution of chloride of zinc (ten grains to the ounce). The patient made a favourable recovery. The temperature never rose above 102·2°, and was normal after the sixth day. Six months later the patient was found to have retained a very useful joint, free from swelling, and possessed of considerable movement.

Arthritis.

When inflammation attacks a joint, it always begins either in the synovial membrane or in the bones. Neither the ligaments nor the cartilage are subject to primary inflammation. The changes they undergo are always secondary.

Though, however, the affection originates in the synovial membrane or the bones, it usually soon extends to the other structures, so that all alike are involved. This condition is termed arthritis. Arthritis has many forms. It may be either acute or chronic, traumatic, infective (as in pyæmia, gonorrhœa, etc.,) or diathetic (as in struma, gout, rheumatism, etc.). Of these varieties, some only will here be noticed, while others, *e.g.* the pyæmic, gonorrhœal, etc., are described elsewhere.

Symptoms.—Attacked with acute inflammation, the joint is placed in the position of greatest ease, in that, namely, which it habitually occupies during rest, and in which the articular ends are relieved as far as possible from mutual pressure, and the ligaments and the capsule are as far as possible relaxed. The shoulder remains with the arm close to the side; the elbow and knee are somewhat flexed; the wrist a little dropped; the ankle a little extended; the hip, in a typical case, is flexed, abducted, and rotated outwards. The local symptoms are those of acute inflammation, *i.e.* pain, heat, swelling, and often some redness of the skin. Pain is throbbing or bursting in character, often so intense that the patient screams with agony if the limb is moved, or even if the bed is jarred. Nocturnal exacerbations are severe, and, whenever he attempts to sleep, the patient is disturbed by spasmodic startings and jumpings of the limb, the latter symptom indicating that the articular ends beneath the cartilage are affected. Increased heat is

easily detected, either by the hand or the surface thermometer. Swelling, which is usually considerable, is due mainly to fluid in the joint, but it depends in part on swelling of the synovial membrane, and effusion into the periarticular tissues.

Constitutional disturbance is often severe, and the temperature ranges from 100° to 104°. When carefully treated from its onset, the affection may subside; but often it advances to suppuration. This event is indicated by further rise of temperature, and often by the occurrence of rigors, as well as by an increase of pain and swelling; the integuments become red and œdematous so that they pit on pressure; soon, as the ligaments become either softened or destroyed, the articular ends of the bones tend to undergo displacement; grating is often detected, and the patient loses sleep and appetite, becomes flushed and emaciated, and has copious perspirations. In some cases the quantity of matter formed is not great; in others matter rapidly increases, and unless evacuated, bursts through the distended and softened capsule, and becomes widely diffused through the limb, which is largely œdematous; the skin is ruddy or dusky, and pits deeply on pressure, and it becomes evident that not only the joint itself, but also the adjacent soft structures of the limb, are disorganised.

Diagnosis.—Abscess outside a joint may resemble acute arthritis. In external abscess, however, there is no uniform distension of the joint, but the swelling is irregularly placed, and both it and the fluctuation to which it gives rise are confined to one aspect of the articulation, and are noticed also to be superficial to the various bony prominences and strong ligaments, *e.g.* the patella or the ligamentum patellæ; or the olecranon and triceps tendon. The joint is not fixed, and admits of movement without severe pain; fluctuation is distinct; there is no abnormal mobility of

the ends of the bones on each other, and no grating. Constitutional disturbance is not severe.

Acute traumatic arthritis sometimes occurs from a severe crush or wrench; it usually, however, follows a wound in which infective changes have taken place. This is a very dangerous form, prone to pass on to suppuration, and rapid disorganisation and destruction of the joint, attended with high temperature, rigors, and severe constitutional disturbance.

Acute infective arthritis, met with in pyæmia, puerperal and scarlet fever, and other allied conditions, is almost equally formidable; the symptoms are usually acute; suppuration ensues, and the joint is quickly destroyed. Another variety of acute arthritis is that which is secondary to disease of the articular ends of the bones, as met with chiefly in young subjects during the growth of the epiphyses. Here, as suppuration about the epiphysis advances, the articular cartilage is perforated, and pus, or the detritus of the ulcerative process, escaping into the interior of the joint, leads to a violent arthritis, which, in the course of a few days, entirely destroys the articulation. Very rarely acute arthritis occurs from the extension of erysipelas or cellulitis to the interior of a joint, or from the bursting into it of an abscess in the neighbouring soft parts, *e.g.* when abscess in the popliteal space bursts into the knee joint.

Treatment.—In acute arthritis, the first point is to secure rest in a favourable position. Should suppuration ensue the matter must be evacuated antiseptically. Should disorganisation of the joint occur, the question of amputation presents itself. Where, however, arthritis has arisen, in the course of pyæmia or puerperal fever, or of any of the exanthemata such as scarlatina or typhoid, the general condition forbids the operation, and the treatment must be expectant, in the hope that a

stiff joint may be obtained; or that, later, as the original disease subsides, amputation may be ventured upon. In the arthritis secondary to disease in the articular ends of the bones, which sometimes is very rapidly destructive, and which is most frequent in subjects under eighteen, and common in children of five or six, amputation may be called for. It can, however, as a rule be avoided, by freely opening, washing out, and draining the joint; by maintenance of complete rest; and by the continued use of antiseptics. It should be resorted to only when the patient's general condition is threatening to become serious to life, as shown especially by rapid wasting, failure of strength, and increasing pallor, the results of pain, and loss of appetite and sleep. Should acute arthritis decline, recovery and the restoration of the functions of the joint may be promoted by the means alluded to for the treatment of the subacute and chronic forms of synovitis.

The *acute arthritis of infants*, described by Mr. T. Smith,* is referred to under Epiphysitis.

Epiphysitis.

The rapid growth which in early life takes place between the epiphysis and the shaft of the long bones, involves an instability, as the result of which healthy nutrition is apt to be supplanted under the influence of feeble health, struma, or local injury, or the presence of some septic or other irritative material in the blood, by inflammatory action. This process, termed *epiphysitis*, is not usually met with after the age of eighteen or twenty, when nearly all the epiphyses have coalesced with the shafts. It is most common under the age of ten. It may be acute, subacute, or chronic; but in all cases alike, one of the main dangers is that the disease may extend into, and lead to inflammation

* St. Barthol. Hospl. Reports, vol. x.

of, the neighbouring joint. It is now well known that a very large number of examples of joint disease in children are secondary to disease originating in one of the adjacent epiphyses. (*See* page 119.)

The **acute arthritis of infants,** described by Mr. T. Smith, is a case in point. Here, generally in infants under a year, and often only a few weeks old, sometimes from local injury, sometimes from absorption of septic material from the umbilical cord, or other source, the epiphysial line of growth becomes the seat of acute inflammation, quickly running on to suppuration, with the result that pus, breaking down the soft tissue of the epiphysis itself, travels towards, and soon bursts into the joint, sometimes by a mere pin-hole orifice, but often by a large, ragged opening in the articular cartilage. Upon this, acute inflammation of all the structures of the joint ensues. The articular cavity rapidly becomes distended with pus, the synovial membrane, ligaments, and cartilages are destroyed by ulceration, and even the articular ends of the bones themselves are lost, so that disorganisation of the joint is complete ; the capsule bursts, and a large, plainly fluctuating periarticular abscess holding sometimes as much as fifteen ounces, is formed, and burrows widely in the limb. This affection may involve any of the large joints, but the knee, hip, and shoulder most often suffer. Sometimes several joints are attacked in quick succession. The malady is often fatal by exhaustion. On the other hand, when the case is seen early, and matter is evacuated before the joint is involved; or if, when pus has reached the joint, the articulation is at once freely opened and drained, many patients recover, and may even retain perfect movement of the limb. In other instances, though the patient recovers, the joint is left useless and flail-like, the ends of the bones consisting of mere stumps connected by fibrous tissue.

The treatment consists in the immediate antiseptic evacuation of pus (if possible before it reaches the joint), free drainage by strips of guttapercha tissue, the use of a splint to prevent deformity, and of liquor cinchonæ and brandy to support the strength.

In *subacute* or *chronic epiphysitis* in older children, the disease, which is often dependent on struma, usually begins at the junction of the epiphysis with the shaft, and spreading through the substances of the epiphysis towards the joint, produces either chronic synovitis; or, if matter bursts suddenly into the articulation, a violent and destructive general arthritis.

Symptoms.—In *acute epiphysitis* the joint is kept in a fixed position, and is stiff, painful, and tender. There may be obvious swelling of the articular end of one of the adjacent bones, with tenderness on pressure and redness of the skin. Within a few hours after it is reached the joint becomes distended and the swelling rapidly increases, so that an abscess bursting through the capsule forms a collection of from two or three to as much as twelve ounces among the muscles of the limb. In epiphysitis of less violent character the symptoms are of a similar nature, but of proportionately diminished severity.

In all cases of epiphysitis the surgeon's chief anxiety must be to avert the impending affection of the joint. In the early stage the limb must be kept at rest on a splint; in acute cases one or two leeches are often very useful. Should matter form it must be at once let out. When swelling, local tenderness, pain, and high temperature indicate that matter is probably enclosed in the epiphysis, an incision should be made over the tender spot, and the epiphysis should be cautiously perforated. If matter is found, an adequate portion of the superficial wall of the cavity containing it should be removed so that pus

may readily escape towards the surface. Though not invariably, yet frequently, the cases described by Brodie, as chronic abscess in the articular extremity of the tibia (a similar condition is met with in other bones), are examples of chronic epiphysitis, followed by suppuration.

When the epiphysis at the growing end of one of the bones (the upper end of the humerus and tibia, the lower end of the femur, radius, and ulna) has been long involved in slight chronic inflammation, the increased blood supply may lead to increased growth, and the limb may become an inch or even two inches longer than its fellow. On the other hand, should epiphysitis have been acute and destructive, the subsequent growth of the bone may be to a great extent arrested. Last year I saw a girl, aged nineteen, at St. Bartholomew's Hospital, whose humerus, the upper end of which had been the seat of destructive epiphysitis in infancy, was four inches shorter than its fellow.

A formidable and not rare effect of acute epiphysitis and ulceration in the line of junction with the shaft, is the complete detachment of the epiphysis. The upper epiphysis of the femur, when thus separated, being left without adequate blood supply, perishes, and forms a sequestrum. In the case of other epiphyses, however, though necrosis is still the rule, repair may occur, and the epiphysis may regain its attachment. During epiphysitis, especially at the upper end of the tibia, though no complete separation occurs, the connection of the epiphysis and the shaft may be so weakened, that, either at the time, or during subsequent use of the limb, the junction may yield, and a deformity which is very difficult to remove, and which greatly impairs the use of the limb, is produced. Should displacement be observed, it must be at once arrested by appropriate mechanical support.

SCROFULOUS DISEASES OF THE JOINTS.

We are still without a concise and adequate definition of scrofula, or its synonym, struma. We can only say that it is a defective condition of the general health, with a tendency to various forms of chronic inflammation, as of the lymph glands, cancellous bone, mucous and synovial membranes, and the skin, tending to pass on to suppuration and caseation of the effused products. In a considerable number of instances well-marked tubercle is present, while in other cases of more limited duration or of lower intensity, no histological elements beyond those of mere chronic inflammation are produced. The scrofulous process arises either when healthy nutrition fails and deviates, apart from any obvious external cause, into a low form of chronic inflammatory action of the type just mentioned; or when the same result follows disturbance of nutrition by some local agency, such as injury, etc. (*See* page 131, and page 216, vol. i.)

The chief clinical characters of scrofulous inflammations are their origin, either spontaneously, or as the result of some trivial local injury which in a healthy subject would have been quickly repaired; their tendency to suppuration and caseation; their proneness to advance, extend, and relapse; their occurrence chiefly in phthisical families; their multiple development in the same family, or in the same patient; and their prevalence between the ages of three and seven, a period of life during which general tuberculosis and tubercular meningitis are more frequent than at any other time, and when local injury is certainly not more common than it is a few years later.

When we meet with children who come of a phthisical stock, and who suffer without any obvious cause from a variety of tedious local inflammations; when, in the same family, several children

are affected ; and when it is observed that as one inflammatory lesion is slowly repaired, or while it is still in progress, others are developed under conditions that exclude the ordinary exciting causes of inflammation in healthy subjects, we appear to be dealing with a morbid condition quite as definite as many to which distinct names are assigned, and one for which, at least for the sake of convenience, some general heading should be used. Yet former conceptions of scrofula, as to its inveteracy, its inevitably destructive action, and its association with any profound dyscrasia, undoubtedly require revision. These chronic inflammatory processes, which we group under this name of scrofula, are very much what they are allowed to become. Probably no affections are more dependent on external conditions, on the difference between careful treatment and neglect. Many a child, who, between the ages of three and seven, is the subject of various forms of scrofulous inflammation, such as caries of the spine and of the tarsus ; ophthalmia or otorrhœa or ozæna, if well managed, subsequently becomes to all appearance perfectly healthy, and remains free from any return of these affections. Present experience, indeed, clearly demonstrates that the traditional view of scrofula has been derived from cases in which the disease, allowed to run its course, has attained a stage of development and assumed characters which appropriate treatment would easily have prevented. In short, when it is opposed in its outset and subsequently by suitable treatment, scrofula in the great majority of cases is merely a chronic inflammatory process, formidable in no other sense than that it is tedious and prone to relapse. These observations will now be applied to scrofulous diseases of the joints.

These affections are most often developed between

the ages of three and seven or eight, and although they not rarely commence after this period, they grow more and more infrequent as age advances. The disease takes its origin either in the synovial membrane or the ends of the bones, but with what relative frequency it is not easy to say. It must here suffice to state that synovitis is common in all the joints except the hip, though here also it is certainly met with. In this joint disease most frequently begins in the bones, either the head of the femur or the acetabulum. When disease arises in the articular ends it commences either just beneath the cartilage (subchondral caries), in the epiphysial line of growth, or in some spot in the cancellous tissue, often in the neighbourhood of the ossific nucleus. It subsequently involves the joint by extension of the inflammatory process, either gradually or by the sudden entrance of pus into the articular cavity.

Symptoms.—Scrofulous synovitis, of which a good illustration is found in the knee, is usually chronic, constituting white swelling or tumor albus. It may, however, be more or less acute, either when it follows injury, or is secondary to disease originating in the bones. In the usual chronic form the joint is a little flexed, and cannot be completely straightened; movement, though it may be free in the middle range, is restricted before the extreme natural limits are reached; there is, though it may be slight, puffy swelling of the synovial membrane, most apparent where the joint capsule is thin. Some abnormal heat may be detected with the hand or the surface thermometer, but it is often inappreciable. Pain, it is most important to notice, is often entirely absent; lameness, though almost invariably present, may be so slight as to escape all but a very observant examination. Muscular wasting soon occurs, and is often one of the most trustworthy symptoms. For the

symptoms met with in particular joints, *see* under "shoulder," "elbow," etc.

All the above symptoms must be critically investigated, for undoubtedly incipient strumous disease is unfortunately often overlooked, and the affection, thus left to itself, steadily advances, and frequently, by involving other structures, passes on to a general arthritis. Under these circumstances the membrane becomes thickened and gelatinous (pulpy degeneration), the ligaments and cartilages are eroded, or in great part destroyed, and the joint on manipulation is often abnormally "loose"; while in the knee, hip, and wrist serious displacement occurs. Effusion is seldom present in any large amount, but slow suppuration may lead to the formation of flaky or cheesy pus. In other instances the inflammation is plastic, and the effused lymph undergoes organisation, so that although the disease has never assumed an active form, and no suppuration has taken place, firm fibrous or even bony ankylosis may occur. These cases of "quiet" strumous disease, ending in absolute stiffness, are more common than many suppose. When mischief begins in the ends of the bones (*see* Epiphysitis) the joint is at first free; but there is enlargement, together with pain, tenderness, and puffy swelling at the seat of disease, and local heat; while, as soon as the joint is reached, the symptoms of synovitis, above described, become apparent. Sometimes synovitis remains slight and subacute, often with intervals of apparent recovery; in others, when the joint is suddenly inoculated with pus, acute arthritis is immediately developed.

Treatment.—It is a law to which no exception can be safely made, that a strumous joint must be kept at absolute rest. The view that, because the disease is "constitutional," local treatment is not so important as that the patient should have exercise in

the open air, is completely erroneous. Fresh air is, of course, of the highest value as an adjunct to local treatment. Yet local treatment must invariably stand first. If these joints are, from the onset of the disease, kept at rest, their recovery, often with completely free movement, is, in the great majority of cases, merely a question of time. Even those that are more or less stiff are strong, useful, and free from deformity. For the details of the treatment of hip disease *see* page 287. The knee is best enclosed in leather

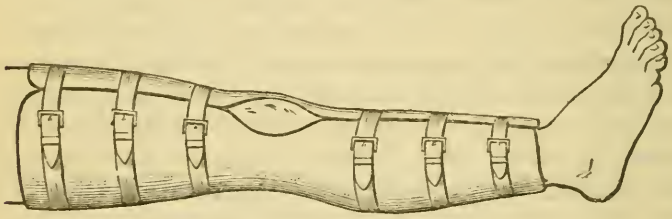

Fig. 51.—Leather Splint for Knee.

splints (*see* Fig. 51) till all active disease has subsided. Then Thomas's splint may be used. The remaining joints should be kept in leather splints (Figs. 52, 53, 54), these being removed every two or three days, while the skin is gently sponged and dried, and then immediately re-applied. In the meantime, the patient must not put his foot to the ground, or make any use whatever of the joint. Everything depends on the absolute manner in which these rules are carried out. If matter forms it should be evacuated antiseptically.

The period required for recovery must vary with the case; from three months, to nine or even twelve months, being the necessary time; while if the disease is already of long standing the time must be extended to eighteen months or even two years. Excellent recoveries may be thus secured, in cases

that would otherwise come to excision or amputation. It is quite certain that if the patient is well fed, and is in a well-aired room, or in the open air when the weather is suitable, enforced rest will not materially impair

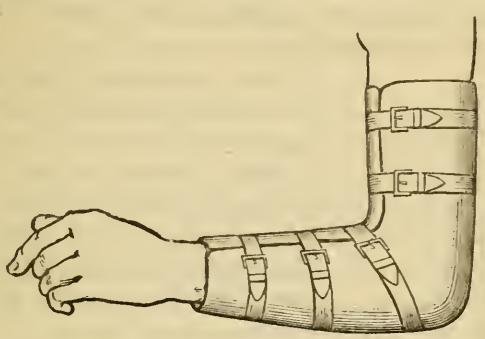

Fig. 52.—Leather Splint for Elbow.

the general health. The period of rest must in each case be determined by the previous duration of the disease, and the readiness, or the reverse, with which

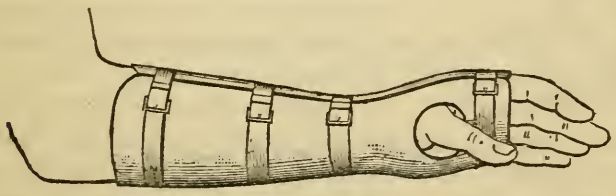

Fig. 53.—Leather Splint for Wrist.

the symptoms subside. As a rule, however, rest should be maintained for at least three months after all signs of disease have disappeared, and active exercise should be very gradually renewed. The danger always is that it may be resumed too soon. It is a common belief that if joints are kept long in a fixed position they will become stiff. This is a fallacy. Stiffness

results when inflammatory action has led to ankylosis. Hence the surest way to avoid this result is to subdue the inflammation by rest. Many a joint retains unimpaired motion after it has been at rest for six months, or even for upwards of a year. In those cases, and they undoubtedly occur, in which stiffness follows long rest, the result is due not to rest, but to the plastic character of the inflammatory process. Another fallacy is that joints often become permanently fixed by muscular rigidity ensuing during enforced rest. Such a result is, to say the least, very rare.

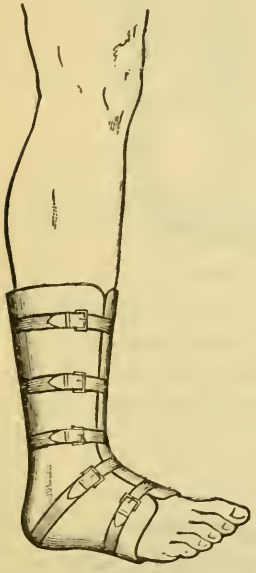

Fig. 54.—Leather Splint for Ankle.

With local rest must be combined a dry climate, fresh air near the sea, where this is practicable, nutritious diet, warm clothing, and tonics, of which cod-liver oil is the best during cool weather, and the more easily digested preparations of iron in the summer months.

Before leaving this subject reference may be made to "senile scrofula," a term given by Sir James Paget* to cases in every respect resembling scrofulous affections as they are met with in children and adolescents, except that they occur in persons from fifty years of age and upwards, sometimes in patients past seventy. Diseases of this nature attacking the joints, usually the wrist and elbow, but occasionally the hip, knee, and other articulations, either spontaneously or after some slight local injury, run sometimes a chronic, but, in other

* Clin. Lectures and Essays.

instances, a rapid and destructive course, quickly going on to suppuration and disorganisation of the joint. Even in their milder forms they prove little amenable to treatment, which should be that already laid down for scrofula: while when they are acute they quickly advance to a stage in which amputation may become necessary.

Pulpy degeneration. — This term has come down to us from Sir B. Brodie, who applied it to instances in which "the synovial membrane was converted into a brown pulpy soft mass, from a quarter of an inch to an inch in thickness, intersected by white membranous lines, and studded with red spots, formed by small injected blood-vessels," while "vascular fringes projected into the cavity of the joint, a good deal resembling, both in appearance and structure, the appendices epiploicæ of the large intestine. The semilunar cartilages were entire, but were in a great measure concealed by the pulpy substance projecting over them. The cartilages were in a state of incipient ulceration." Observing that at the commencement of these cases there was neither pain, tenderness, nor other sign of inflammation present, that the enlargement of the joint began almost imperceptibly, and increased steadily, and that there was no pain even on movement, Brodie held that the disease was "no more inflammatory in its origin than morbid growths generally are in other organs." Later research, however, has shown that these changes are not dependent on any form of new growth, but that they are due to an insidious and frequently intractable form of chronic inflammation of the synovial membrane, often tubercular in character. Hence, by common consent, the term pulpy degeneration is dying out, and is now seldom mentioned, except (as here) to avoid confusion as to the sense in which it was originally used.

Loose Bodies.

These are most common in the knee, but they are also occasionally found in the elbow, hip, and shoulder. In the other joints, though not unknown, they are extremely rare. They present the following varieties :

1. Though Hunter's view, that coagulated blood in a joint might undergo conversion into a mass of cartilage or bone, was erroneous, those loose bodies which present a merely fibrinous structure may possibly (though clear proof is wanting) be derived from altered blood clot.

Fig. 55.—Loose Body from Joint.

2. Blood extravasated into a synovial fringe may become organised and form a pedunculated body, and, when the stalk gives way, fall loose into the synovial cavity. Specimens exist to show this.

3. When a synovial fringe or a patch of subsynovial tissue has become, from injury or some other cause, enlarged and thickened, and when it is caught and dragged upon by the movements of the joint, its base is gradually drawn out into an elongated pedicle, and it becomes a floating body. Such a body may long remain attached ; but its stalk may at length give way so that it falls free into the cavity of the joint (Fig. 55). Bodies of this origin consist of connective tissue and fat, often mixed with inflammatory products, covered with endothelium.

4. Synovial fringes, hypertrophied in the course of chronic rheumatic disease, or of osteo-arthritis, often become converted into cartilaginous bodies by overgrowth of the cartilage cells, which, as pointed out by

Rainey and Kolliker, are normally present in them. These bodies remain for a time attached by a pedicle (Fig. 56), but this at last gives way and they become free. Such bodies consist of hyaline cartilage, or of fibro-cartilage which, however, may undergo calcareous degeneration, or be converted into true bone.

Fig. 56.—Loose Bodies in Joint.

5. After a severe contusion or other local injury, a portion of articular cartilage may, as described by Sir James Paget, undergo "quiet necrosis," that is, may perish independently of any overt sign of inflammation, and be shed into the joint (Fig. 57). In other cases the mass so necrosed and cast off includes not only the articular cartilage, but also a portion of the subjacent bone (Fig. 58).

6. Or a piece of cartilage, or cartilage and some of the subjacent bone, may be chipped off, and fall into the joint.

7. The nodular masses that form about the joints in osteo-arthritis may project into the articular cavity attached by a thread of synovial tissue acting as a pedicle. In many cases the pedicle at length snaps and they are free (Fig. 59).

8. Mr. Shaw has recorded a case in which a loose body was found, on removal, to contain the point of a broken needle. Probably the needle, accidentally embedded in the subsynovial tissue, had, by causing irritation, led to the formation of the body which had subsequently become detached.

Joints in which loose bodies are contained are

often otherwise healthy, or subject from time to time merely to slight inflammatory attacks when the body is caught between the articular surfaces so as to inflict mechanical injury. In classes 4 and 7, and often in class 3, the joint is the seat of chronic rheumatism, or osteo-arthritis. In hydrarthrosis the synovial membrane often presents nodular masses of cartilage, or thick fringes that produce analogous symptoms.

Fig. 57.—Loose Body from Joint.

A, Anterior, and B, posterior surface.

Loose bodies are frequently single, but their number is subject to wide variety. In osteo-arthritis there are often as many as from six to twenty or more. Lately, at St. Bartholomew's Hospital, Mr. T. Smith removed 415 bodies from a knee joint; of these only five or six were attached. The pathology of this remarkable case was obscure.

Symptoms.—These vary with the nature of the body itself, and the condition of the joint in which it is present. In a typical case (*e.g.* of quiet necrosis, or in which a mass of cartilage has formed in a hypertrophied synovial fringe, and has become detached, the joint being otherwise healthy), the patient while walking is seized with such agonising pain, coming on as suddenly as if he had received a blow, that, losing all power in the limb, he falls, overcome with a sense of momentary faintness. Sometimes the joint remains freely movable, and the patient can walk, when in

Fig. 58.—Loose Body from Joint.

the course of a few minutes the pain goes off. In other cases the limb becomes fixed at an angle of about 130°, and any attempt at movement causes unbearable suffering. This stiffness may remain for a time, and then, on some movement of the limb, suddenly disappear. It may, however, continue till the joint is surgically manipulated. (*See* page 258.) The accident

Fig. 59.—Loose Bodies from Joint.

is followed by sharp synovitis indicated by pain, heat, swelling, and stiffness lasting two or three days.

Often the patient detects the body, and ascertains either that it remains in one situation (when attached), or shifts to different parts of the joint. Probably loose bodies are most commonly felt in the pouch over the external condyle of the femur. The agonising pain alluded to is produced when these bodies are caught between the joint surfaces, so that the ligaments are severely stretched and the articular surfaces contused by the powerful leverage with which the bones act upon each other.

The articulation remains fixed when the body is caught and held like a stone in the hinge of a gate, but usually the cartilage slips away as pressure increases, and the joint is freely movable again. The symptoms may return frequently when the body

is of moderate size and movable. But when it is large, and can be caught only in certain positions, the attacks occur at wider intervals; once a month, or even in three or four months. In osteo-arthritis, or other conditions in which the joint is extensively diseased, the symptoms are much less characteristic; but there is still the occurrence of sudden pain coupled with arrest of movement, and the fact that either the patient or the surgeon detects the body.

Treatment.—Formerly the complications ensuing upon wounds of the large joints were so formidable that the removal of loose bodies by cutting down upon them (the "direct method") involved, as numerous published tables have shown, a mortality of at least twenty per cent. This was considerably reduced by the introduction of the valvular or "indirect method." In this, an instrument like a large-sized tendon knife, but with its blade mounted on a long shank, is passed through the skin at a distance of an inch and a half from the cartilage, and is carried horizontally onwards till the body is reached. The synovial membrane is then freely divided, and the knife, when it has been slightly withdrawn, is moved from side to side in the subcutaneous fat, so that a space, or a pocket, is formed. Into this the cartilage is slipped. Here it may be allowed to remain permanently, or, when the wound in the synovial membrane has healed, it may be cut down upon and removed. A serious drawback to this method is that it is apt to fail, even in the hands of experienced operators, either because the synovial membrane has been insufficiently divided, or a large enough space has not been formed in the peri-articular fat for the reception of the cartilage, or because the cartilage is not free, but still attached within the joint.

Hence, at the present day, when it is the experience of every surgeon that if due precautions are

taken to avoid the entrance of septic materials the large cavities, like the peritoneum, may be safely opened, the direct method is almost exclusively in use. It is thus performed: The cartilage is securely held (at some spot where the joint capsule is thin) by transfixing it with one or two strong steel needles, (of which a trustworthy assistant should have charge), exposed by a careful dissection, and extracted. Any bleeding should be arrested before the joint is opened. If the body is attached its pedicle must be divided, having, should it appear vascular, been first tied with fine catgut. The wound is then brought together with fine catgut sutures, which should include the synovial membrane, and dressed with carbolic gauze; and the limb is placed on a back splint so that absolute rest is maintained. Healing generally takes place by the first intention, and there is no rise of temperature. This proceeding, properly carried out, is so free from risk that it may be recommended without hesitation in cases in which the joint is free from advanced disease, and the patient is sound and not far past middle age; and it may be regarded as in all respects preferable to the indirect method. In instances of osteo-arthritis or rheumatic disease, in otherwise sound patients, in whom multiple adventitious bodies materially interfere with the functions of the joint, all those that are completely loose, or that can easily be removed, should be extracted; while others should be left till they become troublesome; in elderly or unsound patients it is best not to operate, especially if, as is not rarely the case, a knee cap or a pad and bandage suffices, as the joint is no longer the seat of vigorous movement, to relieve the symptoms.

The diagnosis between cases of loose bodies and cases of internal derangement of the knee joint may be gathered by referring to page 257.

Displaced Semilunar Cartilage.

Hey, under the title of internal derangement, and Sir Astley Cooper under that of subluxation of the knee joint, were among the first to point out the main clinical symptoms of cases in which the semilunar cartilages of the knee are displaced. The general impression that the internal cartilage is most often involved is probably true, but cases are not rare in which the external is at fault. The following conditions are met with : (*a*) In a healthy joint, during a violent effort, often of rotation, one of the cartilages at some part of its circumference may either protrude or slip inwards, in relation to the condyle of the femur. In such cases either a prominent rim or a deep sulcus may exist over the site of the cartilage. (*b*) The strain on the cartilage may be so great that its marginal attachments are partly or completely torn through, and the disc may be displaced, its anterior portion slipping back entirely behind the corresponding condyle ; or the whole cartilage slipping inwards, so as to lie in the middle line, in the intercondyloid notch of the femur. (*c*) The cartilage may not only be uprooted at its circumference, but be also torn across, so as to slip about like a pedunculated loose body. (*d*) The end attachment of one of the cartilages may be torn away, bringing with it a fragment of the tibia. (*e*) In cases of old synovitis, especially in rheumatic subjects, the attachments of the cartilages become elongated, so that, acquiring too wide a range of movement, they frequently slip out of place. (*f*) After injury, the external cartilage, and perhaps the internal, though I have seen no examples, may become enlarged and thickened, so that on certain movements of extension and rotation it protrudes widely, and can be very distinctly felt. I have met with two cases in which this condition was very clearly marked. (*g*) R. W.

Smith has recorded a case in which the internal cartilage was accidentally transfixed by a hackle pin, and apparently torn, or partially separated, from its connections, so that it could be felt protruding beneath the cicatrix of the wound, where it interfered considerably with the movements of the joint. Displacement of these cartilages, though most common during the vigorous period of adult life, may occur, as the result of injury, in children of six or eight, or in elderly persons whose joints are the seat of chronic rheumatic effusion. (*See* page 200.)

Symptoms.—These vary with the nature of the case. When in a healthy joint the cartilage is driven, by a sudden screw movement of the femur and tibia on each other, out of place, but without laceration of its attachments, the pain at the moment is as severe as that attending the slip of a "loose cartilage," and the joint is found partially flexed and "locked," and perhaps with some deviation of the axis of the tibia, often in the direction of abduction. The patient cannot usually move the joint, yet on manipulation, though it is locked against full extension, it admits of partial flexion.

Sometimes the disc is felt protruding; or it may have so slipped inwards as to cause a deep tucking in of the skin; often, however, nothing can be seen or felt on external examination, and the accident must be inferred from the "locked" condition of the knee. In a few hours all the signs of a more or less acute synovitis generally come on.

When the attachments of the disc are widely torn, the cartilage, from the moment of the injury, slips freely about, and the joint goes "in" and "out" with every attempt at movement. Subsequently the slip becomes less frequent, and occurs only on certain movements, usually of flexion, or flexion combined with rotation.

Many patients know exactly how to put the "joint out," and can thus materially help the surgeon in forming a diagnosis. In cases in which the attachments of the cartilage have become relaxed by chronic synovitis, or otherwise, the joint is liable to become suddenly locked and painful on any casual movement; *e.g.* as the patient rises from his chair, turns in bed, or crosses one knee over the other. Sometimes the lock is only momentary; in other cases the joint remains fixed. The slip is at first followed by synovitis, but after a time the joint becomes more tolerant, and the subsequent heat and swelling are little marked. In the intervals between the attacks the joint is, to all appearance, normal.

Treatment.—In many cases, though the "slip" causes some momentary pain, and is followed by two or three days of synovitis and lameness, the cartilage at once passes back into its place, and does not, therefore, lock the joint. In others it remains displaced so as to lock the joint until it is set free, either by some accidental movement, or by manipulation of the limb. If overlooked, the displacement may remain for some weeks, or even months. Many patients know how either to move the limb, so as to effect reduction, or to direct a passer-by to do so. Sometimes one movement has the desired effect, sometimes another. The plan most likely to succeed is to bend the knee to the fullest extent; a movement which, by relaxing all the ligaments, and separating the articular surfaces of the bones as far as possible from each other, tends to disengage the cartilage; then to freely rotate the tibia upon the condyles of the femur, at the same time that the bones are drawn as far as they can be apart, and then suddenly, but not with undue violence, to carry the limb into full extension. During these movements firm pressure with the thumb should be made on the cartilage at any point at which it seems

over-prominent, or where there is tenderness. Sometimes reduction is effected with a snap, to be distinctly felt or heard. In many cases an anæsthetic is highly advisable, or, indeed, necessary, in order to secure muscular relaxation and so limit the amount of force that is required to extend the limb.

In these cases of slipping cartilage it is not enough merely to effect reduction. Means must be taken to prevent a return of the displacement. For this purpose, one or other of the clamps shown in Figs. 60, 61, will be found extremely useful. Fig. 60 shows a light semicircular steel spring, passing behind the joint, and ending in two plates, which embrace the edges of the patella and make pressure on the lateral parts of the joint. Fig. 61 shows two jointed bars, one for the outer and one for the inner sides of the joint, connected above and below with steel semicircles, and fastening above and below the patella with straps. To either clamp a pad for pressure over any part of the cartilage that protrudes may be added.

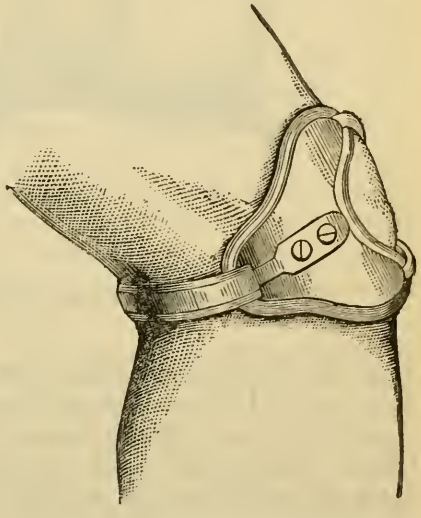

Fig. 60.—Clamp for cases of Displaced Cartilage.

In a case, in which the cartilage was torn across, the joint remained useful after the lacerated disc had been removed. This example, together with others that have been recorded, is important, as showing that the removal of the semilunar cartilages involves no

material impairment of the function of the joint. Such an operation, however, can be very seldom required, and ought never to be undertaken until all other means, especially the use of the clamps described above, modified according to the case, have been tried and have failed. In instances in which displacement has followed recently on an injury, or relaxation of the attachments of the cartilages resulting from recent synovitis, the use of the clamp

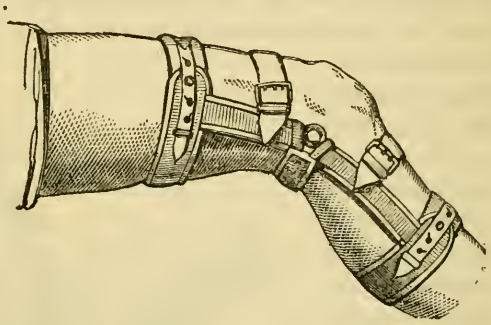

Fig. 61.—Clamp for Cases of Displaced Cartilage.

may be discontinued after from three or six months to a year. In some cases, however, it must be permanently worn. Many patients find themselves able, when wearing the clamp, to play tennis or take any form of active exercise without recurrence of the slip.

In those rare cases in which repeated attempts have failed to secure reduction, the joint will gradually acquire fairly free movement as the cartilage adapts itself to its new position.

Tumours of Joints.

Very important cases are occasionally met with in which the question arises whether we have to

deal with some inflammatory or other disease of a joint, or with a new growth in the articular end of one of the bones. Tumours that imitate joint disease most commonly involve the original growing ends of the bones, that is, the upper end of the humerus and tibia, the lower ends of the femur, radius, and ulna. Hence the question of diagnosis between tumours and joint disease mainly, though by no means exclusively, concerns the shoulder, the wrist, and the knee. Tumours near joints belong generally to the sarcomatous group; some are myeloid in structure, some round or spindle-celled. Some, however, are entirely cartilaginous, or sarcomatous with a large admixture of cartilage. Some spring from the interior of the bone, while others, probably the majority, are subperiosteal. In the course of their growth they impinge upon and at length come to occupy the cavity of the joint, and lead to the entire destruction of the synovial membrane, ligaments, and cartilages, as well as the articular end of the bone in which they have originated; and to wide displacement and deformity of the joint.

The likeness of a new growth to joint disease is sometimes so close that great care is required to avoid an error that may lead to disaster. This is the case when the new growth is soft and elastic, and when it is seated in the immediate vicinity of, or has even extended to, the synovial membrane, so that both by its position and its consistence it may be mistaken for a mere inflammatory thickening of the latter structure; and when, moreover, as not rarely happens, the growth, by interfering with the circulation, has led to effusion into the cavity of the joint. Such tumours, which are usually subperiosteal, generally grow towards the joint in the form of fleshy or spongy, ill-defined or flattened lobes surrounding the bone, and merging imperceptibly into the adjacent soft structures; or of

firm nodules closely abutting on the joint. The joint diseases which they may closely resemble are (*a*) synovitis attended with some effusion, but mainly characterised by considerable pulpy thickening, and induration of the synovial membrane; (*b*) certain forms of chronic rheumatism or osteo-arthritis with synovial effusion, and irregular nodular enlargement of the articular ends of the bones. The main points indicating the presence of a new growth are the following: A new growth is irregular and, as a rule, extends in some directions obviously beyond the confines of the joint. The shaft of the bone, as well as its mere articular border, is distinctly enlarged; the swelling at the part most remote from the joint is often hard, nodular, lobed, or tuberose; one bone only is affected; movement of the joint within certain limits may be free. Enlargement is usually rapid and continuous, so that in three months the disease has attained considerable size; the lymphatic glands may be enlarged. Pain, heat, effusion, and distension of the cutaneous veins are symptoms on which in respect to diagnosis little dependence should be placed. In new growths pain may be either slight, moderate, or severe; heat of the surface and general rise of temperature may be as marked as they are in mere inflammatory joint disease; the cutaneous veins are often enlarged and conspicuous in some forms of synovitis. Some guidance may be derived from observing whether the patient presents any evidence of the strumous or of the rheumatic diathesis, or is suffering from disease of any other joint; and the history of the case, and of the patient's family, should be inquired into. Should doubt remain, the disease should be very closely watched, careful measurements should be taken, and the case should be treated as if the affection were inflammatory, with rest and well-fitting splints, or with such remedies as the features of each particular case may suggest. It may even be

advisable, due care against septic infection being taken, to remove a portion of the disease for microscopic examination, so that diagnosis may be completed and the appropriate treatment entered upon without delay.

Treatment.—The treatment of tumours of the articular ends of the long bones involving the joints is laid down in Art. II. Here it will be sufficient to remark that the choice must lie between amputation of the limb, and enucleation of the growth; or in the case of the upper end of the humerus, or the lower extremity of the ulna or radius, excision of the end of the bone. The latter proceeding may be adopted when the tumour is either myeloid or cartilaginous, and not too extensive; but in other instances amputation should be performed. As some uncertainty usually remains, an incision ought always to be made into the tumour before amputation itself is proceeded with.

The Question of Excision in Joint Disease.

In estimating the value of excision as a means of treating diseases of the joints it is at once apparent that the question, far from turning on any simple issue that can be concisely stated, is one in the discussion of which several important considerations have to be taken into account. This, however, is not always borne in mind. Some authorities are, as many think, too ready to look at excision merely as a surgical operation, whose success is in itself enough to secure a verdict in its favour. But the fact that the wound will heal rapidly, so that the patient will be up and about in a few weeks, is not enough to justify a resort to such an operation as the excision of a large joint. It must first be shown that there are no means of a less heroic kind that will secure a still better, or even an equally good, result.

Operations rest in different cases on different principles. Now the principle of excision is the same as that of amputation, or the removal of an eye-ball or a testis. That is, it abandons all attempt to cure disease, and falls back on the somewhat primitive expedient of cutting away the part in which the disease is placed. Although there are many circumstances in which the surgeon is driven to adopt this kind of operation (*e.g.* in dealing with malignant disease), it is obvious that it should be avoided whenever, in the interest of the patient, it is possible to do so.

It must be remembered also that the necessity for an operation often depends on the stage which surgery has reached. Many operations formerly called for have, as surgery has improved, been to a great extent, or even entirely, set aside. Some thirty or forty years ago the treatment of inflammatory diseases of the joint was so little understood, that these affections commonly went on from bad to worse and to the development of formidable complications, until amputation of the limb was the only course that remained for relieving the patient from intolerable suffering, and enabling him to follow some occupation, or even for saving his life. At this period a great advance was made when Sir W. Fergusson and others introduced excision as a substitute for amputation, and endeavoured, by removing the affected joint, to save the remainder of the limb. Since that time, however, our knowledge of diseases of the joints has been considerably increased, the means of forming an early diagnosis have been attained, and the efficacy of early treatment on the principle of complete rest has been amply demonstrated. It has also come to be well known that, if due precautions are taken, a joint in which suppuration has occurred may be freely opened and drained as safely as any other large abscess cavity, and that in the majority of cases thus treated the patient

recovers with a very serviceable limb. Under these circumstances, it would, at first sight, appear that the necessity of resorting to any large operation, whether amputation or excision, involving the sacrifice of the affected joint, had been set aside, and that the broad principle of conservative surgery, the cure of disease rather than the cutting away of the organ in which the disease is placed, would be as applicable in the case of the joints as in any other field of practice.

Arguments for excision. — There are, however, three grounds on which some surgeons still advocate the frequent resort to excision as a means of treating strumous joint disease: (1) that the operation saves time; (2) that, as tuberculosis is present, recovery without operative interference is very improbable; (3) that by removing the structure in which tubercle is deposited, the danger of general tuberculosis is averted. None of these arguments will bear close examination.

1. In the first place, the time saved (in other words, the rapidity of repair after excision) turns on the period of the disease at which the operation is performed. In many cases of long-standing disease, in which the tissues have become widely degenerate, so far from time being saved, the wound often never heals at all; or it heals only after a period (extending over many months, or even over two or three years) that would have much more than sufficed for cure by continuous rest. In many instances the disease is entirely unchecked, or considerably aggravated by the operation. The only cases in which rapid healing can be depended upon are those in which such slight changes have taken place that continued rest would certainly lead to recovery, and often to the restoration of perfectly free movement in the joint. Besides, it is obvious that rapid repair is not everything. If it were,

amputation ought to be performed in many compound fractures, and even for many lacerated wounds.

2. To the proposition that as tubercle is commonly present, recovery without operative interference is improbable, the reply is, first, that microscopic investigation shows that tubercle is often absent in the early stages of these affections ; and secondly, that whether tubercle is present or absent, cases which are treated by rest will, in all but very exceptional instances, end in recovery, a fact attested by the circumstance that excision is scarcely ever performed for patients in the middle or upper classes.

3. The view that excision averts or largely diminishes the liability of systemic infection is met by the observation, first, that tubercle is, as already mentioned, often absent ; that general tuberculosis is rare as a sequel of articular disease (page 287); that even in cases in which tubercle is present, it is impossible to ensure its complete removal by excising the affected joint, or to guard against the existence of other and more active centres of infection elsewhere, *e.g.* in some part of the lymphatic system.

Obvious drawbacks to the general resort to excision are, first, that repair will not take place unless the patient is in fairly good general health. Hence, to secure what are termed good results, the operation must often be performed early, that is, when rest alone would have sufficed to effect a cure. At later stages the operation frequently entirely fails, the wound remaining unhealed, suppuration continuing, and the case, unless amputation is performed, ending fatally by exhaustion or amyloid disease. Secondly, the limb after excision is, as a rule, much less useful, even when favourable repair has taken place, than after recovery without operation. After excision of the knee in patients under ten (and the conditions for which the advocates of excision

employ the operation, are much more common before than after that age), the limb is, in many instances, so short and deformed by gradual yielding that it is in great part or entirely useless.

These remarks, unavoidably much condensed, are not intended as a sweeping condemnation of excision, but as supporting the view that the operation is one, even at present, of very limited application, and one that is destined in the future to fall more and more into disuse.

In the case of the joints, as in that of the eye, the testis, and numerous other instances, true progress lies in the direction of cultivating early diagnosis, in diffusing a knowledge of the great importance of attacking disease before serious structural changes have occurred, and in the adequate application of the principle of rest. When all this has been done, the necessity for such a proceeding as excision will very seldom arise.

Cases adapted for excision.—In the meantime, however, there are various instances in which excision should be adopted. These, in the case of the *hip*, are mentioned at page 293.

In the *knee*, excision is mainly of use in cases (*a*) in which the bones are in good condition, but where, as the result of subacute synovitis of long standing, attended with relaxation of the ligaments, so much displacement has occurred that the limb cannot be brought into a serviceable position; (*b*) in which, though displacement is limited, the synovial membrane is the seat of extensive pulpy degeneration, a condition in which repair is very unlikely to take place. The operation is not generally suitable when the patient is under five or even seven; when disease is acute; when the bones are extensively involved; or when the general health has broken down.

As to the value of excision in the other

articulations, the *shoulder joint* is comparatively seldom diseased, it is easily kept at rest, and shows a strong tendency to gradual recovery, it is liable to no deformity, and although the joint almost invariably becomes stiff, compensatory movements at the elbow and between the scapula and the trunk are so free that the limb remains useful. Hence, excision is very seldom either called for or performed, and certainly the limb, after it, is generally much less serviceable than after repair by continued rest.

The *elbow* is, of all the joints, that in which excision yields the best results. As growth takes place at the upper extremity of the humerus, and the lower extremity of the ulna and radius, the removal of the elbow joint ends of these bones does not materially affect the length of the limb, nor is length here a matter of much importance. If sufficient bone is removed to prevent ankylosis, and if the anconeus is preserved, free motion and considerable power are secured; the amount of repair to be effected is comparatively small. Yet even in this instance it is only in cases that have been utterly neglected that excision can be necessary; for if the joint is kept at rest and in good position, the disease will very rarely indeed become serious; on the contrary, it will undergo steadily advancing repair. Even when suppuration occurs, if the joint is opened antiseptically, provision made for free drainage, and rest is continued, recovery will still, as a rule, ensue.

Excision of the *wrist* for disease is a rare operation, generally attended with very limited success. There are but very few cases in which disease of this joint, when adequately treated by rest, does not end in recovery, and the restoration of considerable or even unimpaired movement; whereas, after excision, the movements and strength of the hand are alike very seriously impaired. Usually the removal of any of the carpal

bones that are provoking prolonged suppuration is better than a systematic excision.

In the case of the *ankle*, as in that of the wrist, excision is both rare, and, as a very general rule, inadvisable. In the early stage disease readily yields to treatment by continued rest; in the later stage it is very rarely confined to the end of the tibia and fibula; it much more commonly involves the tarsus also, so that the astragalus and perhaps some other bones must be removed; it is difficult to perform the operation without injuring surrounding tendons and other important anatomical structures; repair is tedious, and the limb is apt to be subsequently less useful than it is after a Syme's amputation of the foot.

As to excisions in patients over twenty-five, it must here suffice to say, that although successful cases have been recorded, the operation in the case of the hip and the knee is so formidable to life that it cannot be generally recommended. Amputation is almost constantly the safer alternative. In the other joints, especially the elbow, excision may, in properly selected cases, yield good results in healthy subjects in whom disease is not acute, and in whom the bones are not extensively involved.

The Question of Amputation in Joint Disease.

It has been pointed out that inflammatory affections of the joints are amenable, in a degree that was entirely unsuspected even a few years ago, to appropriate treatment; and the opinion has been expressed that when, instead of being allowed to advance until serious structural changes have occurred, these diseases are adequately treated in their incipient period, excision will fall almost entirely into disuse. The same may be said of amputation for joint disease, although it will probably in the future become the more common operation of the two. As matters

at present stand, however, disease, in a considerable number of instances, reaches an incurable stage, and becomes associated with various complications, and amputation is all that remains to be done.

The *grounds for resorting to the operation* may refer either to the joint itself or to the general condition of the patient. Thus, in some instances in which the disease has become so advanced that there is no probability of repair by rest and its accessories, the ends of the bones are so extensively involved that excision is inadmissible; in others copious suppuration and wide burrowing of matter through the limb preclude excision; in acute disease, should the question between excision and amputation arise, amputation, as a rule, had better be performed.

As regards the general condition of the patient, it must, as already said, always be remembered that satisfactory repair after excision of a large joint will take place only when the patient is in fairly good health. Hence, a state of exhaustion or feebleness, and the cachexia of advanced tuberculosis, are conditions which tend to preclude repair, or at least to render it very doubtful. In these cases, on the other hand, amputation is usually followed by rapid recovery.

The age of the patient is a very important point. Subscribing to the great principle of conservatism, every surgeon, if his choice were free, would prefer excision to amputation. Experience, however, has amply shown, that in many cases amputation is the better operation. In children under five the articular ends of the femur and tibia are so largely cartilaginous, that firm union after excision often fails to take place. In adults, say after, at the latest, thirty years of age, the risks of excision are so great, and those of amputation so comparatively small, that the latter operation should, as a rule, be performed. In dealing with the advanced forms of

joint disease, it is very important not to misjudge the case so as to allow the period at which amputation would succeed to pass by.

The grounds for resorting to the operation without further delay have reference chiefly to the patient's general condition. So long as this is not unfavourable, expectant treatment by rest, etc., may be persevered in; but should it be found that the patient is steadily losing appetite and strength, that he is also losing flesh (always a highly important point), that the temperature remains high, that sweating is copious, and that the pulse is becoming smaller and more rapid, further delay is dangerous. Especially in these cases must a watch be kept for the appearance of albumen in the urine, and for enlargement of the liver, as evidence that amyloid degeneration of the viscera has commenced. Formerly it was supposed that this condition precluded operative interference, but it is now well known that if the suppuration on which it depends can be arrested, this complication will generally disappear. This is the case, however, only when amyloid degeneration is of recent date. When it is of long standing, not only is it irremediable, but it is extremely likely to determine a fatal result if amputation is performed.

Diseases of Individual Joints.

Shoulder.—*Strumous affections* of the shoulder joint are common in childhood and early adult life. Disease may begin either as synovitis, the most usual form, or as epiphysitis of the humerus, soon extending to the joint itself. In either case the affection is generally subacute; often so insidious that it is apt to be overlooked. Pain is often absent, or very slightly marked; it is felt in or around the joint, or near the insertion of the deltoid. The most prominent symptoms are wasting of the deltoid and of the scapular

muscles, and stiffness of the joint, the scapula following the humerus both when the patient moves the arm, and when an attempt is made to rotate the humerus in the glenoid cavity. The arm remains at the side, and no deformity is produced. Suppuration is rare, but in epiphysitis abscess may form beneath, and at length point at the anterior border of the deltoid, or in the axilla. The shoulder is so easily kept at rest, its movements being so readily performed between the scapula and the thorax, and at the elbow, that disease of the joint, though it may be tedious, shows a marked tendency to recovery. Treatment consists in maintaining rest by keeping the arm bandaged to the side; and if it is thought necessary, a leather shield splint may be moulded to the joint and upper half of the arm. Even in early cases rest should be continued for at least three or four months. If abscess forms it should at once be opened antiseptically. In epiphysitis necrosis is rare, and operative interference is seldom required. Should a sinus, however, remain unclosed, in spite of continued rest of the joint, it should be carefully explored. If a sequestrum is detected it should be removed, but generally no carious or inflamed bone should be gouged away.

As the result even of slight disease this joint usually remains stiff, and the question of endeavouring to restore movement by manipulation presents itself. The necessity of interference after mere sprains or contusions is now well understood; but when stiffness has followed disease manipulation will very seldom be attended with benefit, while it will often be injurious by provoking a return of inflammatory action. This is especially the case in strumous disease.

Acute arthritis is common in this joint in infants under two. As its result, a large collection of matter is rapidly formed beneath the deltoid, sometimes extending forward under the pectoral

muscles as well as into the axilla. The upper end of the humerus is often completely destroyed, and with the loss of the epiphysis the subsequent growth of the bone is arrested, and the arm may ultimately be three or four inches shorter than its fellow, and remain weak and flail-like. *Treatment* consists in the early evacuation and free drainage of matter, and in supporting the strength of the patient by the means already described (page 240). In *pyæmia and septicæmia* the shoulder is often the seat of the rapid formation of a large abscess, which gives the joint a globular or rounded outline. Fluctuation is very distinct. In some instances, however, effusion is merely serous, and may undergo absorption. *Charcot's disease* and *osteo-arthritis* are common in the joint. In the latter, the articulation becomes stiff and painful; cracking or grating is felt on movement, muscular wasting is marked; and pain of a dull aching or gnawing character is complained of either in the joint itself or the outer part of the arm beneath the deltoid. As the disease advances the articular surfaces become altered in outline, and the head of the humerus, enlarged by osteophytic growths around its margin, is found to be displaced upwards and forwards so as to imitate the appearance of subcoracoid dislocation. This should be borne in mind, and in any case of obscure injury of the shoulder in an elderly person careful inquiry should be made into the previous condition of this joint before any step is taken to effect the reduction of what at first sight may be erroneously mistaken for a recent dislocation. For the treatment of osteo-arthritis *see* page 278. *Syphilitic disease* of this joint is extremely rare (page 224). I have never met with any instance of it.

The elbow.—*Strumous disease*, both in the form of synovitis, and of osteitis, beginning either in the

articular end of the humerus or the ulna, is of very frequent occurrence. The joint is more or less, but sometimes very slightly, restricted in its various movements; puffy swelling, especially over the head of the radius and by the sides of the tendon of the triceps (giving the joint an appearance of increased width when viewed from behind) is well marked; there is often, but by no means invariably, increased heat of the surface; muscular wasting, especially of the arm, is a constant, often a very early, symptom. The disease is generally chronic, but it may be acute, and pass on quickly to the formation of matter, distending the synovial membrane and pointing either at the outer or inner aspect of the joint. Pain is seldom a marked symptom, and is often so entirely absent that parents, and even the surgeon, may be misled. Stiffness, puffy swelling, and muscular wasting, are, in fact, the most reliable symptoms. *Treatment* consists in the use of well-fitted leather splints, confining the joint at a right angle (Fig. 52), the arm being kept in a sling. Matter, if any form, must be evacuated, a "window" being cut in the splint to allow of drainage. Though stiffness sometimes remains when inflammation is plastic, perfectly free movement is often regained when treatment has been applied early and has been sufficiently prolonged. The splints must be continued for from three months to nine months, or even, in older cases, for a year or more. When the articular ends of the bones are carious it is useless to gouge away the inflamed structures. With rest the osseous tissue will very usually regain a healthy condition; but this failing, or where the extensively diseased synovial membrane continues to suppurate in spite of long-continued rest, excision will be indicated.

Acute arthritis of infants is frequent in the elbow. The joint, often within two or three days,

becomes the seat of a large abscess, and the articular ends of the bones, as well as all the ligamentous structures, are rapidly destroyed, so that the humerus and bones of the fore-arm are widely movable in all directions on each other. In early cases, if matter is at once evacuated, this extensive destruction may be avoided, and the joint may regain all its normal movements, while in cases in which treatment has been neglected the joint remains weak, loose, and flail-like. The elbow is a common seat of *Charcot's disease*, and often presents, in a characteristic form, the changes induced by this affection. The joint becomes, sometimes very rapidly, enlarged and deformed by the accumulation of fluid in the interior, and in adventitious periarticular bursal sacs; and also by the destruction of the articular surfaces of the bones and the heaping up of irregular osteophytic masses about the ends of the shafts. The joint admits of abnormally free motion and coarse grating is felt. There is, however, little or no pain, and the patient uses the limb freely. *Osteo-arthritis* often involves this joint, though less frequently than it does the knee, hip, and shoulder. The usual symptoms of slowly increasing stiffness, pain of a dull wearing character, cracking and creaking on movement, together with the presence of the disease in other joints, frequently, among the rest, in the opposite elbow, will render diagnosis very easy. For treatment *see* page 278. In the course of *pyæmia* and other forms of blood poisoning, the elbow (an articulation, however, which often escapes) presents lesions, the features and treatment of which have been described (page 227). *Syphilitic disease* of the elbow joint is not rare, and probably many instances of chronic and relapsing inflammation in adults, attended with thickening of the synovial membrane and not yielding to the prolonged use of rest, have been of this character (page 224)

Wrist.—In children and young adults, and even occasionally in old persons (page 248), strumous affections are prone to attack this joint, which becomes slightly flexed, swollen, and puffy, both on the dorsal and palmar aspects; normal depressions between the tendons are lost, and the part assumes a smooth fusi form outline, the result of synovial thickening. A well-marked feature is impairment of the movements of the hand, especially of pronation and supination; and the power of grasping objects firmly is lost. Muscular wasting of the fore-arm is always present; pain and surface heat are very variable symptoms; they are often absent in cases in which the joint is in a state of advanced disease. *Treatment.*—The joint must at once be enclosed in leather splints (*see* Fig. 53), and the fore-arm supported in a sling, the patient being forbidden to make any use of the limb. Cases are very rare in which recovery will not follow, if this plan is adopted early and continued for the necessary period of from three to six months. In advanced cases the time must be extended to a year, or even longer. If suppuration occurs, matter should be evacuated, and drainage provided for. When, in spite of three or four months of rest, suppuration continues to be free, it should be ascertained, with as little disturbance of the structures as possible, whether any of the carpal bones have become necrosed and loose. If any are so found they should be removed; but if the bones are merely inflamed, or in a state of caries, they should be left for repair by a still longer period of rest; for here, as in all other cases, the gouging away of inflamed or carious bone will have the effect of aggravating rather than of removing the disease. In cases of extensive disease some surgeons resort to a systematic excision of the wrist joint. Very generally, however, a better result will be obtained by long-continued rest, combined

with the removal of any sequestra that are from time to time found to be loose. It is difficult, without experience, to credit the amount of repair that will follow this treatment by rest perseveringly maintained. *Osteo-arthritis* frequently attacks this joint, which becomes stiff, particularly as regards pronation and supination, and painful; swelling, usually slight, in some instances becomes considerable, as the result of ganglionic enlargement involving the sheaths of the flexor and extensor tendons. Such cases are always tedious, but much good may sometimes be done by placing the limb in splints, carefully evacuating any large collections that may have formed, by antiseptic puncture, blistering the joint for five or six weeks, and then applying Martin's indiarubber bandage, to secure uniform pressure. In the management of *pyæmic* and other forms of blood poisoning, affecting the wrist, the main points, locally, are the support of the joint so as to prevent deformity, and the early antiseptic evacuations of matter. *Syphilitic disease* of this joint appears to be very rarely met with. I have never seen it.

Hip.—The remarkable features of *Charcot's disease* of the hip are detailed in Art. xxix., vol. i. *Osteo-arthritis* of this joint was formerly designated morbus coxæ senilis, or from the fact that, especially in males, the hip is often the only joint attacked. *Monarticular rheumatism.*—The affection commences, usually in persons over forty-five (though it may be met with earlier), with pain about the joint, or at the back of the thigh in the course of the sciatic nerve, or in the neighbourhood of the knee; gradually increasing lameness and stiffness, so that the patient is unable to stoop or dress himself; and wasting of the muscles of the thigh and hip. As the disease advances all the symptoms become more pronounced. Pain is often constant and severe. The limb becomes gradually shortened and everted, and on examination it

is found that, as the result of absorption of the upper border of the acetabulum and head of the femur, the trochanter has become displaced so as to lie considerably above Nélaton's line (page 283); shrinking of the limb continues, and lameness becomes extreme. These cases are often, in their early stage, mistaken for sciatica. A correct diagnosis, however, can at once be made by testing the movements of the hip. *Treatment.*—The patient should wear flannel over the joint, so as to secure warmth at a uniform temperature, and should take moderate exercise. Complete rest promotes stiffness. Blisters and liniments of opium and belladonna often diminish pain. Hot fomentations and douching give relief, and many patients find great benefit from the hot douche treatment at Buxton, Harrogate, Wildbad, Baden, or Aix-les-Bains. If urates or deposits of uric acid are present in the urine, five grains of the citrate of lithia should be given once or twice daily in potash water. Usually the limb remains in a position of extension, and no splints or other mechanical appliance are of any service. Occasionally by manipulation, under an anæsthetic, motion may, for a time, be increased by the detachment of osteophytes around the joint and the rupture of adhesions, but, as a rule, forcible movement aggravates rather than improves the condition of the limb, and it should not, therefore, be adopted without careful consideration. *Acute inflammation* of the hip joint, developed in the course of *pyæmia* and other kinds of blood poisoning, is formidable in the highest degree. Pain is usually very severe, the joint quickly becomes disorganised, and the patient is threatened with death by exhaustion. The joint must be, at the very outset of the disease, placed at rest by the application of a weight to the foot, combined with the use of a Thomas's splint, or of an interrupted long splint, and matter should be evacuated, either by the aspirator or by antiseptic incision,

and free drainage be provided. In young subjects, should other conditions be favourable, amputation may sometimes be performed; but in adults this step generally cannot be ventured upon. In the course of *typhoid fever* the hip (apparently more often than any other joint) is liable to be attacked with inflammation, attended with the same symptoms as are met with in ordinary hip disease. The affection is usually subacute, and rarely goes on to suppuration; serous effusion, however, is often considerable, and spontaneous dislocation is apt to occur. In any case, therefore, should the patient complain of pain, careful examination should at once be made, and if the joint is found stiff and sensitive on movement, weight extension should be applied (page 287), the limb should be supported between sand-bags, and a cradle placed over the foot to prevent pressure by the bed clothes.

In *gonorrhœal rheumatism* the hip is very liable to be affected. The symptoms are those of an acute or subacute and very persistent inflammation, which often leaves the limb completely fixed by adhesions within and around the joint. Suppuration, though very rare, is occasionally met with. In its active stage the case must be treated on the plan given at page 287. Subsequently, in order to restore movements, manipulation, under an anæsthetic, followed by hot douching, shampooing, and passive movements, and repeated, if necessary, at the end of a fortnight or three weeks, will be required. These means will often succeed, but no undue violence must be used; nor should forcible movement be persisted in if it is followed by severe pain that does not quickly subside, or by marked swelling about the joint.

Strumous Disease of the Hip Joint.

This affection presents so many special features as regards its symptoms and diagnosis, the course it takes,

and the treatment it requires, that it is convenient to describe it under a separate name. It must, however, be understood, that it differs in no material respect from those chronic diseases of the other joints, which are generally regarded as strumous or scrofulous.

Although met with at any age up to puberty, and occasionally in middle and even in advanced life, hip disease most frequently begins in childhood between the ages of three and seven. It originates most commonly in the bones, *i.e.* in the upper end of the femur, or in the floor of the acetabulum. The frequency of disease in these structures is probably due to the fact that, being centres of rapid growth, their nutrition is unstable, and apt, on any disturbance, to pass into inflammatory action; and it is easy to see that as these parts themselves are within the capsule, disease in them must almost inevitably provoke a general arthritis. In a certain number of cases disease commences in the synovial membrane. The view formerly held, that it had its starting point in the ligamentum teres, or in the articular cartilage, is now known to have been erroneous.

Synovial cases, though they are sometimes acute, generally take a mild course, yield readily to treatment in their early stage, and often end, though convalescence is tedious, in complete recovery. Cases in which the bones are affected are much more serious. If carefully treated they, like the synovial form, end in satisfactory recovery, though this may be long delayed. But when neglected they pass on to caries or necrosis, suppuration, and great deformity, and frequently to a fatal result.

Diagnosis.—Well-established hip disease may be recognised almost at a glance; but in the early period, when it is so highly important to form a correct opinion, diagnosis is often attended with great difficulty, first because the symptoms are very slightly

marked, and, secondly, because almost all the individual symptoms of hip disease are also the symptoms of disease either of the spine, or of some neighbouring part. Hence, a correct opinion can be reached only by observing and comparing a number of slight signs, any one of which alone would be quite inconclusive.

Symptoms.—These will be stated in the order in which they would present themselves in an actual case :

1. *Lameness* is always present, but it may be so slight that it is easily overlooked. It is due to the fact that the joint is either in a stiff or distorted condition, or is too sensitive to bear any weight. There is, however, no form of lameness that is in the least degree characteristic of hip disease. The symptom must always be studied in conjunction with other evidences of the disease.

2. *Pain.*—This is very variable both in degree and situation. Sometimes it is so slight, or entirely absent, that the disease is not suspected. Sometimes it is severe from the first. It may be in the joint itself, or transferred to the nerve peripheries, and so be felt either in the knee or the inner side of the thigh or the leg. It must, however, be borne in mind that pain may be referred to these situations in several other diseases, as of the lumbar spine or the sacro-iliac joint, cancer of the rectum, and abscess or aneurism in Scarpa's triangle ; in any case, in fact, in which the trunk or higher branches of either the obturator or anterior crural, which both supply the hip joint, are irritated.

3. *Altered position of the limb.*—In a typical case, in the early period of disease, the joint is flexed, abducted and rotated outwards. Many theories have been advanced to explain this position. It is, however, merely that of greatest ease, and that which we unconsciously adopt as we sit at rest with the limbs flexed on the trunk, the knees apart, and the heels

touching. This position relaxes all the ligaments of the joint. Thus, flexion relaxes the front of the capsule, abduction the ligamentum teres and the outer band of the ilio-femoral ligament, rotation outwards the inner band of this ligament and the back of the capsule.

This position of the limb, however, is generally not at once obvious when we examine the patient. Instead of it we find that the diseased limb is extended, and parallel with its fellow, that the lumbar spine is arched forward (lordosis), that the pelvis is depressed on the affected side, and that the limb looks longer than its fellow. This attitude is thus explained. Obviously a limb that is fixed in a position of flexion and abduction (which, in other words, is pointed forwards and outwards) is useless for progression (Fig. 62). To overcome this difficulty, the patient, by curving the lumbar spine forwards, rotates the pelvis on its transverse horizontal axis, and so makes the femur point downwards instead of forwards; and by curving the lumbar spine laterally, so that the pelvis is raised on the sound and depressed on the affected side, he brings the femur inwards towards the middle line (Fig. 63). The apparent lengthening of the limb is due merely to the fact that the pelvis on that side is depressed; in other words, apparent lengthening always indicates that the limb is abducted. As to real lengthening of the limb this probably never occurs. I have never recognised an instance of it. In the later period of disease, the powerful adductors, under the influence of reflex irritation, draw the

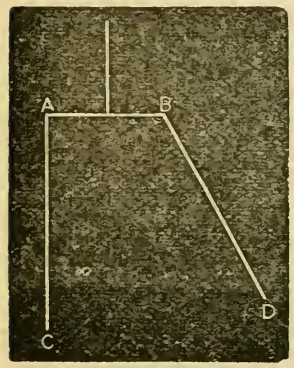

Fig. 62.

limb inwards so that it now becomes flexed and adducted, instead of flexed and abducted (Fig. 64). Here, again, the limb occupies a position (crossing the opposite thigh) in which it is useless. To meet the difficulty the patient curves his spine laterally so as to draw up the affected side, and so brings the femur outwards, till it is again parallel with its fellow, with the result, however, of producing apparent shortening of the limb (Fig. 65). Thus apparent shortening always depends on adduction. At a still later period the limb undergoes real shortening as the upper border of the acetabulum and the head of the femur become absorbed, and the trochanter is carried upwards by muscular action, more or less above Nélaton's line (drawn from the anterior iliac spine to the tuberosity of the ischium). Another cause of real shortening is arrest of growth of the limb.

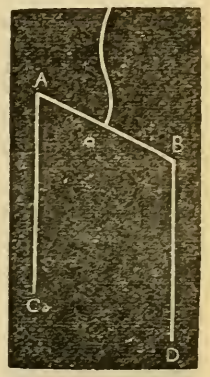

Fig. 63.

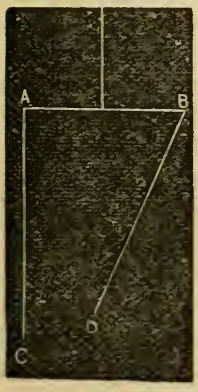

Fig. 64.

4. *Loss of movement in the joint* is the most constant and the most reliable sign of hip disease. Even in the very earliest stage some loss of motion is so constantly present that completely free movement is in itself almost enough to prove that the joint is sound. Various conditions, however, it must be remembered, may interfere with flexion and extension of the thigh on the trunk, *e.g.* psoas abscess will often prevent full extension, while abscess under the glutei will limit flexion. It is necessary, therefore, to ascertain whether, when the

limb is semiflexed, the femur will rotate freely in the acetabulum. If the ball-and-socket movement is free, it may be concluded that the loss of flexion and extension is due to some impediment outside the joint, but if rotation, as well as the other movements, is lost or distinctly impaired, it must be concluded that the joint itself is diseased.

5. *Muscular wasting*, always an important symptom, due mainly to reflex atrophy, but in part to disuse, is constantly present in established disease, and may even be well marked in three or four weeks. It shows itself as flattening of the hip and loss of the fold at the lower border of the gluteus, and also by shrinking of the thigh, accompanied by a flabby condition of the muscles, detected by measuring the two limbs at the same level.

Fig. 65.

6. *Swelling.*—This may be due to general fulness about the joint, perhaps with enlargement of the glands in Scarpa's triangle, and to the presence of abscess, which may be found at any aspect of the articulation.

For examination the patient must be undressed, and lying on some firm surface, so that the real position of the limb can be made out. The surgeon must see whether the knee can be brought down without producing anterior curvature of the lumbar spine (lordosis); whether the heels are level; and whether the anterior iliac spines are horizontal. If when the knee is down the spine is curved forward, it shows that the thigh is flexed. The amount of flexion will be disclosed by raising the knee till the spine is straight. If the iliac spine on the suspected side is depressed (*see* Fig. 63), it indicates that the limb is

abducted, and the degree of abduction will be shown by carrying the limb outwards till the iliac spines are restored to the same level. If, however, the iliac spine of the suspected side is drawn up (Fig. 65), it indicates adduction, the amount of which will be brought out by adducting the limb till the pelvis is again horizontal. The real position of the limb will thus be ascertained. Flexion, and extension of the thigh on the trunk, and rotation of the femur in the acetabulum should now be investigated. This test must be very gently applied, but each movement must be carried to its full natural range, for it is only when the extreme limits are approached that slight restrictions of movement become apparent. Muscular wasting of the limb and swelling about the joint should next be looked for. Sometimes when the joint is grasped from before backwards, between the finger and thumb, enlargement of the upper end of the femur will be detected. Tenderness on carefully applied pressure, either in front of or behind the joint, is sometimes a marked symptom. Jarring of the heel or knee is a worthless test. It often makes a timid child shrink, though the joint is perfectly sound, while often it causes no uneasiness, although hip disease is well marked.

When these various signs have been investigated a conclusion is generally readily formed; but sometimes early diagnosis must rest on two or three slight yet distinct symptoms carefully pieced together, in the absence of some symptoms that are often spoken of as characteristic. Thus there may be no pain either in the hip or knee, no complaint when the knee or heel is jarred, and, to a casual examination, no flexion and no lameness. Close investigation, however, shows that there is slight apparent lengthening, together with slight limitation of complete flexion, slight muscular wasting, and slight lameness. In another case the only symptoms are stiffness and occasional pain

(which parents regard as a "growing pain" or rheumatism), and limitation of flexion and rotation of the femur in the acetabulum. Thus a thorough and critical, but always gently conducted examination, is required. The conditions between which, and hip disease, mistakes are most frequently made, are disease of the spine accompanied with psoas or iliac abscess, disease of the sacro-iliac joint, abscess under the glutei, from whatever cause, infantile paralysis, congenital dislocation of the hip joint, and, in young children, lordosis, due to acute rickets, an affection which imitates hip disease in the circumstance that the limbs are often tender on movement.

Complications.—In a very large proportion of cases in which the disease is allowed to advance, and in some even in which treatment has been at once brought to bear, *suppuration* will occur. Matter is usually formed within the joint, and passes either through the cotyloid notch, or through the bursa under the ilio-psoas, to reach the surface in Scarpa's triangle, or through the thin posterior part of the capsule to appear under the glutei. Some abscesses, however (especially those that appear late in the disease), are outside the joint, and are due to suppuration around the remains of inflammatory exudation. Abscesses may present at any part of the joint, but a common situation is under the tensor fasciæ femoris, on the outer part of the limb. When the acetabulum is affected matter may form within the pelvis and present above Poupart's ligament. Occasionally pus in this situation forms a communication with the intestine, so that fæces escape into the abscess cavity. This complication, happily rare, is usually fatal.

Two serious complications, *amyloid degeneration* of the viscera and *tuberculous meningitis*, must here be referred to. Amyloid degeneration, indicated by albuminuria and enlargement of the liver and spleen, though

usually met with only when discharge has been copious and prolonged, is sometimes present when suppuration is still recent. A watch should therefore be kept for it in all cases in which considerable discharge is going on, for if suppuration can be arrested when the amyloid change is recent, the latter may entirely disappear. At a subsequent period, however, it is not only incurable, but it very greatly increases the risk attending operative interference. *Tuberculosis meningitis* was formerly, when hip disease was so often allowed to reach an advanced stage, much more common than it is at present. But it is still not very rare, and may occur even in cases in which no suppuration has taken place, and at any period, even, indeed, after the joint affection has long been cured. This is a complication that always passes on to a fatal termination. *Pulmonary phthisis* is decidedly rare as a complication of hip disease.

Treatment.—This consists, in the early period of the disease, in absolute rest, and the removal of any deformity that is present. These ends are best secured by extension by means of the weight and pulley. The patient is placed on a firm mattress, with a board beneath it. The weight is applied by means of the well-known stirrup made of stout strapping, the ends of which extend half way up the thigh, so that the ligaments of the knee are not subject to any undue strain.* The weight, which takes effect rather by its constant action than by its amount, should not exceed three or four pounds in children under ten, and five to eight in patients from ten to twenty. Heavier weights than these are seldom required. A long splint should be applied to the *opposite* or *sound* side, to keep the patient on his back in the horizontal position. As to the affected limb, this must be placed in the position to which the disease has brought it.

* This is not shown in the figures.

Lordosis due to flexion must be removed by raising the limb till the spine is straight (Fig. 66). If the pelvis is depressed on the affected side, the limb must be abducted (Fig. 67) till the two iliac spines become horizontal; if, on the contrary, the pelvis is drawn up on the diseased side, the limb must be adducted till the pelvis is again square (Fig. 68). When these directions have been carried out, when, in fact, the real has been

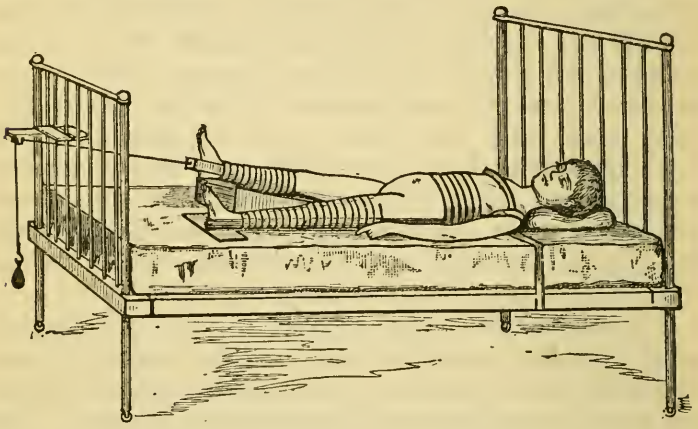

Fig. 66.—Extension in Hip Disease.

substituted for the apparent position, the limb must be supported in this attitude (by pillows, or some light framework), and the pulley must be adjusted so that extension is made in the long axis of the thigh (as shown in the various figures). When this principle is carried out, the weight removes undue interarticular pressure, whereas if extension does not correspond with the long axis of the thigh, the weight acts by leverage, and, therefore, tends to increase, instead of to relieve, the pressure of the femur against the floor of the acetabulum. A cradle should keep the weight of the bed clothes off the foot. As flexion is corrected it is necessary to remove some of the pillows and to shift the pulley, so that the weight may still act

in the long axis of the thigh. Though the weight will remove flexion generally in from a fortnight in recent, to two months in old cases, it has little or no influence either on abduction or adduction.

As to abduction (showing itself as apparent lengthening), this calls for no special treatment. It will gradually disappear if the joint remains movable,

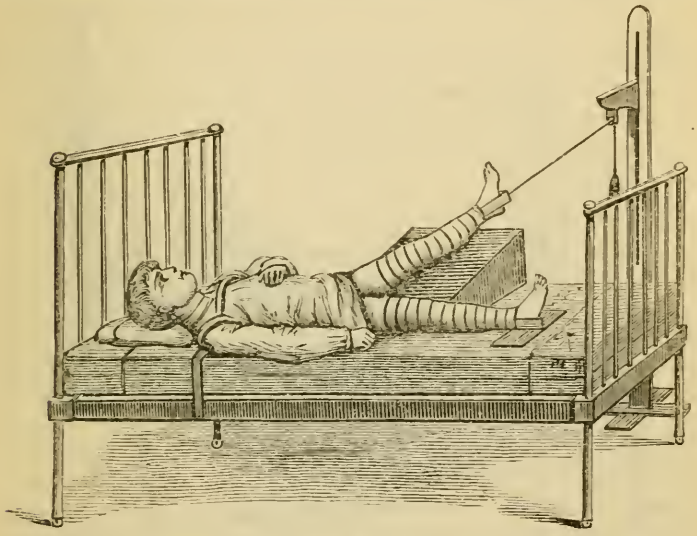

Fig. 67.—Extension of the Limb in a flexed and abducted Joint.

while, if the joint becomes fixed, abduction is an advantage, because the apparent lengthening which it produces will tend to compensate for any real shortening that may have resulted, from either absorption of the articular surfaces or arrested growth of the limb.

Adduction, on the contrary, as it leads to apparent shortening, must, if possible, be removed. For this purpose a pound, or perhaps two pounds, is added to the amount already applied to the affected limb. A long splint is applied to the sound limb (if

this has not already been done), and a cord fastened to the lower end of this splint is run upwards along its outside to the head of the bed, where it turns over a pulley and supports the same amount of weight as that appended to the affected limb. Thus, while the diseased limb is drawn down, the sound limb is drawn in the opposite direction. This method will

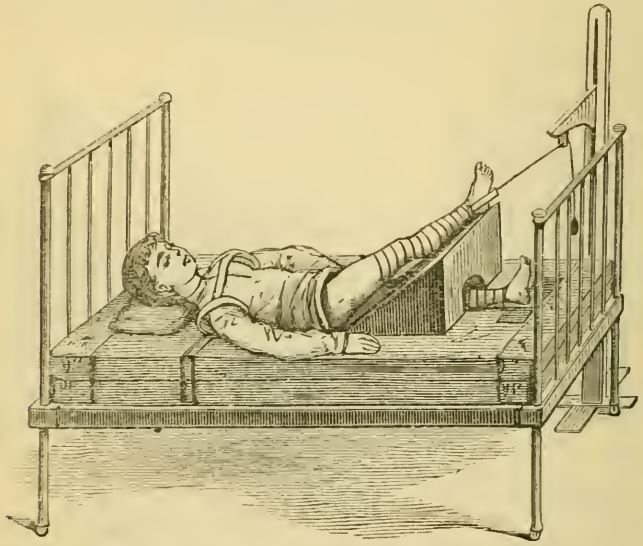

Fig. 68.—Extension of the Limb in a flexed and adducted Position.

generally remove even a considerable amount of adduction, *i.e.* of apparent shortening, in the course of from three to five or six weeks.

In cases of long standing the limb may be so fixed, although there is no anchylosis (it should be remembered that bony anchylosis is rare in hip disease, even when repair has followed long-continued suppuration) that the weight fails to secure extension. In these instances, when the child is under chloroform, the limb may be straightened through two or three degrees, and

then the weight may be reapplied. It will now be found that the limb will gradually come down under the influence of the weight. Very slight force only should be used in this proceeding, and anything approaching the old method of forcibly straightening the limb must be entirely condemned.

Mr. Thomas has invented a splint which has deservedly become popular, and of which a description may be found in any recent work on general surgery. This splint is very useful for the purpose of maintaining absolute rest in acute cases, where it may with great advantage be combined with weight extension. By its help the child can be lifted without disturbance of the joint. It is also very useful in the convalescent stage to prevent a return of flexion. The chief objection to this splint is that, if long continued it is apt to produce muscular atrophy, especially when the bandage used to fix it is applied tightly around the limb. Another drawback is that it does not exercise any extension, so that displacement of the femur upwards and shortening of the limb may take place during its use. However, when necessary weight extension can easily be combined with the splint. The old leather shield splint, and the various forms of plaster of Paris cases are all far inferior, in every respect, to Thomas's splint. The American surgeons, Taylor, Sayre, and others, have invented splints, figured in all the American manuals. Their principle is to maintain extension and mobility of the joint while the patient is allowed to be up and moving about. To be efficient, however, they require very frequent readjustment. They have never become popular in England.

The period during which treatment should be continued varies with the case. It must always, however, be remembered that recovery is slow, and that relapses are very prone to occur, so that the main chance of error lies in remitting treatment too soon. Weight

extension should be continued for at least three months after pain and all tendency to muscular contraction have completely disappeared, and if the case has been acute a full six months should be allowed. The weight should then be *gradually* discontinued, and, if no symptoms are observed, a Thomas's splint may be applied, and the child be allowed to be up on crutches, wearing a high boot on the sound side, so as to keep the foot of the diseased limb off the ground.

Treatment of abscess in hip disease.—The objections formerly valid against the opening of abscesses in hip disease have been set aside by the methods now in common use for preventing septic infection of the wound; and abscesses which used to be left to form large collections, now may, and should be, evacuated as soon as they are detected. When the patient is under an anæsthetic an incision about an inch long is made and kept open with dressing forceps, while matter is gently pressed out so that the abscess is emptied; a piece of drainage tube, just long enough to enter the abscess cavity, is inserted, and the wound is dressed with "protective" and antiseptic gauze in the usual manner. Subsequently the dressings are changed often enough to prevent the discharge from passing beyond the gauze. By this method abscesses may be opened without any rise of temperature, or local disturbance. When this treatment is employed in cases in which the joint disease has become inactive no further suppuration will occur, and the wound will be soundly healed in a fortnight to three weeks; while in those in which active disease is still in progress the abscess contracts, and all that remains is a sinus, which serves to afford exit for any pus that is produced till, as repair advances, suppuration comes to an end. By following this practice of opening abscesses early the extensive burrowing of pus, and the formation of numerous

sinuses about the joint, formerly so common, is prevented, the tissues are relieved from the prejudicial action of retained pus, fever is avoided, and the period of suppuration is largely curtailed.

Excision in hip disease.—With the majority of surgeons excision of the hip is a very unpopular operation; for when it is performed for advanced disease, and when the health has become impaired, the wound frequently remains unhealed, suppuration remains as free as before the operation, and the patient still continues to lose health and strength. In short, the proceeding does little or no good, either locally or as regards the patient's general condition. Meeting with this disappointing experience, some authorities, holding the view (*see* page 265) that the disease is attended with the local deposit of tubercle, and, therefore, little likely to undergo repair without operative interference, and pointing to the advantage of removing the affected structures, and so of averting the risk of systemic infection, recommend that the operation should be performed at an early period, as soon, in fact, as suppuration is detected. In the early stage, however, it is now well known that properly conducted treatment by rest, and the evacuation of matter, will lead to recovery with a much more useful limb than that which is obtained by excision. There are, however, certain conditions for which it is advisable to perform excision, although the result of the operation must often be very doubtful. These are:

1. When the whole head of the femur, or what remains of it, has become necrosed and detached, so as to form a loose sequestrum. This proceeding, however, is not, strictly speaking, an excision, but merely an operation for dead bone.

2. When, in spite of three or four months of complete rest and free drainage, suppuration remains

copious, and the general health is giving way, provided, however, that there is no evidence of extensive disease, either of the femur or the pelvis, or wide burrowing of matter in the limb. When the femur is the seat of chronic osteo-myelitis, which sometimes involves the greater part of the shaft, amputation is the only adequate operation; and when the pelvis is largely diseased, excision will be useful only in securing free drainage. The gouging away of carious bone from the pelvis will very seldom be attended with any good result.

3. When, along with continued suppuration, there is so much displacement of the upper end of the femur that the limb cannot be brought into good position without operation. Here excision may serve the double purpose of removing distortion and of arresting suppuration. In any of the above conditions the appearance of enlargement of the liver, or of albumen in the urine, showing that amyloid disease of the viscera has set in, may be an additional ground for excision, for if the operation can arrest suppuration, the internal organs may perfectly recover. When, however, amyloid disease is of long standing, the operation will not only be useless, but attended with considerable danger to life.

Excision is now performed with much less violence and destruction of parts than was formerly the case, when the custom was to strip the whole upper end of the femur, to force it out through the wound, and saw across the shaft below the trochanters. The operation virtually consists merely in removing the head of the femur, or its remains, by dividing the neck. The trochanter major, in all but exceptional cases, is preserved, and the attachment of its muscles and the surrounding soft parts are as little as possible interfered with.

Operation.—An incision down to the back of the joint is made about four inches in length, and

extending from the base of the trochanter upwards in the course of the fibres of the glutei. The wound is retracted, and the capsule, if still present, is opened. The finger is then passed in to ascertain the condition of the bones and the relation of the neck; a small saw, guided by the finger, is next introduced; the neck is sawn through where it appears to be sound, and the detached portion is removed, with as little injury as possible to the surrounding parts, by extracting bone forceps. Should it be clear that the trochanter is extensively carious it must be removed, but this step, it must be noted, largely interferes with the future usefulness of the limb. The floor of the acetabulum must be carefully examined, and any sequestra removed, and should there be perforation and abscess in the pelvis, free drainage should be provided by removing the necessary amount of bone with a gouge. Bone should not, however, be gouged away merely because it is carious. After the operation the limb may be placed either on an outside splint, interrupted opposite the wound; or between sand-bags with a weight of two or three pounds suspended from the foot to prevent undue retraction and shortening.

The conditions adverse to the success of the operation increase so rapidly as age advances, that excision is very seldom undertaken in patients above the age of twenty. In middle life it is justly regarded as inadmissible.

Amputation.—Surgical opinion has recently moved in the direction of recommending a more frequent resort to amputation, or a means of treating otherwise hopeless cases of hip disease. Experience has shown that the operation is less fatal than was supposed. It is now clearly seen that when the disease has reached a certain stage, it is generally futile to anticipate repair, either from continued rest or from excision. It has often been observed that

children show very great rallying power when a source of exhausting suppuration is removed, and it is known that amyloid degeneration, unless it is of long standing, is no bar to the operation, and may be completely recovered from. Obviously, however, amputation must be performed only when the patient's recovery is otherwise hopeless. The operation is called for :

1. When hip disease is complicated with extensive disease of the femur attended with copious and persistent suppuration, and especially if amyloid degeneration is present.

2. When excision has been performed but has failed to arrest suppuration, and the general health is giving way. Here amputation is much simplified by the previous excision.

3. When the patient is steadily losing ground, and it is believed that he has not strength sufficient to secure repair after excision.

4. In some cases of free suppuration connected with advanced disease of the pelvis, amputation may be advantageous, either by securing free drainage not otherwise possible, or by enabling the operator to remove diseased bone that could not otherwise be reached. Generally, however, extensive disease of the pelvis contra-indicates amputation.

As the patient is already in an exhausted condition, it is of the first importance that little blood should be lost, and that the operation should occupy as short a time as is compatible with its careful execution. Hæmorrhage must be guarded against, either by the use of Davy's lever or of an efficient tourniquet. The method by transfixion admits of being rapidly carried out, but the resulting stump is too short to allow of the adaptation of an artificial limb. If, however, Furneaux Jordan's admirable method is used a long muscular stump is provided, and the patient will, on recovery, be able to walk well on an

artificial limb. Hence the choice of the method in every case will turn on the condition of the patient. If he is in a state to bear a somewhat prolonged operation, Furneaux Jordan's plan should certainly be selected; but if he is so exhausted that it is necessary to complete the amputation with as little loss of time as possible, the transfixion method had better be adopted.

The knee.—This is not only the largest of the joints, but it is singularly liable to disease. Some affections met with here are very rarely seen in any other joint; while if we glance at the various diseases that attack the joints, it is the knee that is, in almost every instance, most prone to be affected. The knee is, after the hip, the joint in which deformity is most likely to occur, and the most difficult to remedy, and in which pain and muscular startings are most frequent, severe, and hard to relieve; in which, while suppuration is frequent, it is the most formidable; in which we are most often driven, in neglected cases, to perform excision or amputation. While, on the other hand, there is no joint in which appropriate treatment is attended with more satisfactory results. It is therefore an articulation which demands special consideration. The features of *strumous disease* are well illustrated in this joint. The affection begins either as a low form of synovitis, often at first circumscribed, but subsequently extending to the whole membrane; or as inflammation of the cancellous tissue (in young subjects epiphysitis) of the lower end of the femur or upper end of the tibia. When disease begins as synovitis, the knee is bent at an angle of about 140°, and though it can be flexed, it cannot be fully extended. If the process is acute the joint may be distended with fluid, so that fluctuation is distinct. Usually, however, swelling is inconsiderable, or so slight that it can be detected only by careful measurement, and is due mainly to thickening of

the synovial membrane, chiefly apparent by the side of the ligamentum patellæ.

In later stages the membrane undergoes pulpy degeneration (page 249) followed by suppuration. The ligaments become softened, and gradually elongated, while, owing to reflex contraction of the hamstring muscles, a remarkable distortion is produced. This is threefold; the bones of the leg becoming flexed, displaced backwards and outwards, and rotated outwards so that the foot is everted. Flexion is due to the action of the hamstrings, while the displacement outwards combined with eversion is due to the fact that the powerful biceps muscle is inserted into the outer and front part of the head of the fibula, and, as a strong fascia covering the tibialis anticus, into the crest of the tibia, so that it is a strong external rotator. Lameness, due to the position of the limb, or to tenderness of the joint, is present. Pain, and abnormal heat of the surface, though often present, are so frequently absent, or so slightly marked, that they are much less reliable symptoms than flexion and puffy enlargement of the joint.

When disease begins in the articular end either of the femur or the tibia, the symptoms, at first very slightly marked, are local pain, tenderness on firm pressure, puffy swelling of the soft parts, lameness, and inability of the patient to completely extend the limb. It is in this form of disease that startings of the limb, due to reflex muscular contraction, make their appearance early, and often gradually increase in severity. As the disease advances the joint itself becomes involved, sometimes by direct extension of inflammation leading to chronic synovitis; but frequently by the entrance of pus into the cavity of the joint through a perforation of the articular cartilage; when this opening is small and indirect, the symptoms are at first not very marked, but when matter in any

considerable quantity bursts directly into the joint, violent and destructive inflammation is at once produced, attended with rapid distension of the synovial cavity with pus, severe pain, high temperature, and constitutional disturbance.

Treatment.—At the earliest moment at which disease can be detected the patient must be forbidden to put his foot to the ground, and the joint must be placed at absolute rest in splints, of which the best form, made of carefully moulded leather, is shown in Fig. 51. These should extend from the upper third of the thigh, nearly to the ankle, so that the whole limb is fixed. They must be worn constantly, day and night, and be removed only twice or three times a week for attention to the skin, and must be immediately reapplied. Thus treated, in the great majority of cases incipient disease will steadily recede, and in the course of from three to six or nine months complete recovery with unimpaired movement will take place. A modification of this plan, when swelling and heat have subsided, is to employ Thomas's knee splint, so that the patient is allowed exercise without throwing weight on the affected joint. If, however, under this method, any return of symptoms is observed, the leather splints and the horizontal position ought to be at once resumed. In cases in which the joint has become flexed, no forcible attempt, either by manipulation or instruments, should be made to straighten it, but the splints should be moulded to its present position. With rest, and the subsidence of muscular spasm, it will, in the course of a few weeks, often within a month, spontaneously subside into a posture of extension. In cases of any standing this process is very gradual, and it is necessary to follow it up by adapting splints whose shape must be altered to keep pace with the improved position of the limb. The improvement produced by rest may

be advanced by a succession of small blisters, or the application of oleate of mercury, or of gentle pressure by means of Martin's elastic bandage. Friction and douching with salt water, etc., means which parents are often so anxious to employ, are usually harmful, as they involve disturbance of the joint. Night screams are best relieved by the use of the actual cautery, lightly applied, and repeated, if necessary, in three or four days; and by combining, with the splints, the use of the weight and pulley. In this case the limb must be raised and supported in such a position that the tibia is horizontal, and that extension acts in the long axis of the leg. When disease involves the ends of the bones, the treatment just described must be carried out. In these instances, however, it is of the highest importance to prevent the extension of mischief to the joint itself. Rest must be scrupulously maintained. Should matter be detected, it must be at once evacuated; and even though no fluctuation can be felt, if local pain, tenderness on pressure, and puffy swelling and redness of the surface are present, the existence of pus must be suspected, and an incision through the periosteum should be made, and the bone should be explored by puncture with a fine drill, and if any matter is found, a free opening should be made, so that the chance of the escape of matter into the joint may be provided against.

Acute arthritis of infants (page 239) is common in the knee. The joint becomes painful, restricted in its movements, and tender to the touch; and pus, rapidly formed in large quantity, distends the joint, and soon becomes extravasated into the surrounding tissues. If incisions are made, and free drainage is provided, as soon as matter forms, and a posterior splint is applied, complete recovery, with free movement, may often be secured. But in neglected cases the ligaments and ends of the bones are rapidly destroyed; and, if the

patient recovers, the joint remains more or less loose, flail-like, and distorted, and the limb is arrested in its growth and useless.

In any form of *blood poisoning* (page 226) attacking the knee, the joint must, if the patient's condition allows, be at once placed at rest on a splint, in the best available position, and covered with warm lead and opium lotion; or, if pain is severe, with a liniment of opium and belladonna. If the joint becomes distended it should be emptied with a fine aspirator needle. If the fluid is purulent, and soon reforms, antiseptic incision and drainage will be called for. In many cases in which the patient's general condition is grave, and in which other lesions are present, if the joint is in a quiescent state and not much distended, it is best to postpone active interference, and merely to secure rest.

Osteo-arthritis, of frequent occurrence in persons over fifty, and sometimes found in much younger subjects, comes on with stiffness and pain (especially marked after rest), weakness, and creaking, grating, or cracking on movement. Swelling due to effusion, though it may be considerable, and even amount to hydrops articuli, is usually only slight. "Lipping," due to the heaping up of new bone along the articular margins, can often be felt; and in advanced cases the patella and the articular ends of the bones become enlarged and altered in shape; while in some instances masses of cartilage, developed in the synovial fringes, and subsequently becoming detached, form "loose bodies" in the cavity of the joint; pain is often severe, and the patient becomes crippled by lameness. The disease generally attacks other joints, especially the opposite knee. For treatment *see* page 278.

Syphilitic disease (page 224), in the form either of synovitis with effusion, or of gummatous infiltration and thickening of the subsynovial tissue, often combined

with periostitis of the ends of one of the bones, is met with more often in this than in any other articulation. Displacement of the semilunar cartilages (internal derangement, or subluxation of the knee joint) is described at page 256, and the subject of "loose bodies" is treated of at page 250.

Ankle.—*Strumous disease* of this joint usually takes the form of an insidious chronic synovitis, though it may arise from extension of inflammation from the lower epiphysis of the tibia, or from one of the tarsal bones. The symptoms are lameness, enlargement of the joint, wasting of the muscles of the calf, and, though these are often absent, pain and heat of the surface, and restricted movement. Swelling, which is frequently in children the most reliable feature, occurs as puffy enlargement by the sides of the tendo Achillis, so that the joint has an appearance of increased width when viewed from behind; but it can also be seen around the malleoli, and in front, beneath the extensor tendons. It is often difficult alike in early and advanced cases, and even when suppuration has occurred and has led to the formation of sinuses, to decide whether disease is situated in the ankle joint or is confined to the astragalus or the os calcis. In early cases this is not very material, as treatment by complete rest is essential in both instances; but in advanced disease the differential diagnosis is highly important. I have more than once known Syme's amputation performed for what was believed to be destructive disease of the ankle joint, but which proved to be caries of the tarsus that might have been dealt with without amputation, while the joint itself was perfectly healthy. The foot should never be removed until the surgeon has convinced himself that a probe passed into any sinuses that exist really enters the joint. In strumous disease of the ankle the joint must be at once enclosed in lateral leather splints

(Fig. 54; page 248), and the patient must bear no weight upon the limb. Any matter that forms must be at once antiseptically evacuated. There are very few cases indeed in which this treatment, combined with cod-liver oil, iron, and good air, will not lead to recovery, usually with restoration of the movements of the joint. *Osteo-arthritis* presents no features calling for detailed description. The disease is usually not confined to the joint, but involves, at the same time, the adjacent tarsal articulations, and is often associated with a very troublesome form of flat foot, resulting from relaxation of the plantar ligaments, a condition which, along with stiffness of the ankle joint itself, greatly cripples the patient. The local treatment consists in protection against cold and damp, and the use of the hot douche or steam bath, moderate exercise, and some support for the plantar arch. When, however, the joint is swollen and tender no mechanical support can be borne, and the patient should be provided with boots of very soft leather or cloth, with low heels and wide soles, while warmth and hot douching are persevered with, and the rules stated on page 278 are carefully followed. The ankle and the neighbouring tarsal joints, together with the fibrous structures of the sole, including all the ligaments, are not rarely the seat of urethral urethritis (page 229) of an acute and severe type. In cases of rapidly increasing flat foot in young adults, the presence of gonorrhœa must not be overlooked. The affection often assumes a severe form, and the arch is completely lost. It is necessary to keep the patient for a time completely off his feet while the treatment indicated on page 231 is being followed. And for some months the patient should rest his feet as much as possible, and should wear either the surgical sole, or some equivalent support.

V. INJURIES AND DISEASES OF MUSCLES, TENDONS, FASCIÆ, AND BURSÆ.

William J. Walsham.

Muscles.

Wounds of muscles, like those of other soft tissues, may be incised, lacerated, punctured, or contused, and call for but few remarks. When a muscle is divided transversely to its fibres, the cut ends contract, causing the wound to gape. They should, therefore, be approximated as much as possible, by placing the part in such a position as to relax the muscle, and sutured with animal ligature, as catgut or kangaroo tail tendon, the wound closed, and the parts placed at absolute rest. When the wound is deep, or longitudinal to the fibres, a drainage tube had better be inserted, as the discharge is likely to be pent up by the bulging of the fleshy belly of the muscle. Should the muscle have lost its contractility, and appear so lacerated or contused that it must obviously die, the injured portion may be cut away. Wounded muscle generally unites by fibrous tissue, but the formation of new muscle fibres has in a few rare instances been observed.

Rupture.—Subcutaneous rupture of a muscle may be caused by a sudden or violent involuntary action, as in trying to save a fall, or during vomiting, or an attack of tetanus or delirium. The muscles, perhaps, most frequently ruptured in this way are the pectoralis major, deltoid, rectus femoris and abdominis, gastrocnemius, adductors of the thigh, and extensor brevis of the foot. The rupture may be complete or partial, and may occur through the muscular

tissue itself, or at the insertion of the muscle into either its tendon or the bone. Union generally takes place by fibrous tissue, but sometimes suppuration occurs, and an abscess results.

Symptoms.—The rupture is attended by local pain, perhaps by a sensation of tearing or snapping. When a few fibres only are torn, the injury may escape notice, though it may be followed for many months by pain and stiffness, which may be attributed to rheumatism. In complete rupture the function of the part is lost. The ruptured ends retract, causing a hard swelling above and below the rent, which can often be felt as a gap; or blood may be extravasated between the ruptured ends, giving rise to a fluctuating swelling, and subsequently, as it makes its way towards the surface, to ecchymosis and discoloration of the skin.

Treatment.— The ends of the ruptured muscle should be approximated by carefully applied bandages or splints, whilst evaporating lotions or an ice bag should be used to control blood extravasation and prevent inflammation. Should a blood tumour form, it should not be opened, as the blood will in time be probably absorbed. If, however, suppuration occurs, an early exit should be given to the pus.

Inflammation and abscess.— Inflammation of muscle, or myositis, may follow an injury such as a strain or rupture of a few fibres; or it may spread to the muscle from the tissues around. It may also occur idiopathically, and is then generally spoken of as rheumatic; and it is of frequent occurrence in septicæmia and pyæmia, when it usually quickly ends in suppuration.

The chief *symptoms* are pain increased on movement, swelling, and, when the affected muscle is superficial, heat and redness. Except when the result of pyæmia, it usually terminates in resolution. Should

an abscess form, rigors followed by fluctuation, and later pointing, or signs of deep suppuration, will be present.

The *treatment* indicated is rest, soothing applications, belladonna or opiate liniments, and, where pus has formed, an early incision.

Hypertrophy, or simple increase in size, may occur both in the voluntary and involuntary muscles. Familiar examples of the former are seen in the muscles of the limbs of athletes; of the latter, in the bladder and intestines, as the result of obstruction to the passage of urine and fæces.

Atrophy and degeneration.—The chief degenerative changes in muscle are: (1) simple atrophy; and (2) granular, (3) fatty, and (4) waxy or vitreous degeneration. In simple atrophy the muscular fibres merely waste and get smaller, but do not lose their striation, and are capable of being completely restored; whilst in the other forms the fibres undergo distinct pathological changes, and their function is entirely and permanently lost. Simple atrophy may occur from a variety of causes. In surgical practice it is, perhaps, most frequently met with as a consequence of the disuse of a part, as for example from chronic joint disease. The granular, fatty, and waxy degenerations occur as the result of acute febrile disease, lead poisoning, scrivener's palsy, disease of the nerve centres, etc. Though sometimes occurring alone, they are often intermixed. They may all be present, as well as simple atrophy, in the following diseases, of which a short account is given.

Progressive muscular atrophy is a disease of adult life, and consists, as the name implies, of a slow and nearly always progressive atrophy of the voluntary muscles, and consequent increasing weakness and paralysis.

The *cause* of the disease is often obscure. It has

been attributed to excessive exercise, exposure to cold and wet, to syphilis, fevers, lead poisoning, and injury of the spine. It is often hereditary, and is more common in the male sex, and in the middle period of life.

Pathology.—Although it is still thought by some to be essentially a primary disease of the muscles, it is now generally held that the wasting of the muscles is secondary to disease of the multipolar nerve cells in the anterior cornua of the spinal cord. These cells, amongst other pathological changes in the grey and white substance of the cord, have been found atrophied and degenerated; but whether such changes should be regarded as inflammatory or degenerative is still undetermined. The muscles appear paler than natural, and in various stages of atrophy. They are said by Charcot to undergo simple atrophy only; but other observers have noticed, in addition, granular, fatty, and vitreous degenerations.

Symptoms.—The short muscles of the thumb and little finger, especially those of the right side, are generally first affected; then the interossei, giving to the hand a characteristic claw-like appearance (the *main en griffe*). Thence the atrophy spreads up the arm to the muscles of the trunk, or missing those of the fore-arm falls upon the deltoid, or attacks the muscles of the opposite hand. In rare instances the atrophy starts in some of the muscles of the trunk, and very exceptionally in those of the lower extremity, but it is exceedingly uncommon for it to spread to them. Previous to the atrophy, pain and cramps or fibrillar tremors in the muscles are commonly noticed. In the later stages the limbs become variously deformed from unequal wasting of the muscles, and the unbalanced action of their antagonists. The muscles respond both to the faradic and continuous current, but more and more feebly as the disease advances, till in the later stages they cease to do so altogether. The reflexes, which may

at first be increased, steadily diminish, but are never quite lost till the muscle is entirely destroyed. The sensibility of the skin is never affected, neither does it undergo atrophic changes; the bladder, the rectum, and the sexual functions are not interfered with. The patient usually dies from some bronchial trouble, consequent upon the weakness of the respiratory muscles.

Treatment.—There is no known remedy for the disease, but phosphorus, arsenic, and cod-liver oil may be given internally, whilst blisters to the spine, galvanism, and the hot baths of Aix-la-Chapelle should be tried.

Pseudo-hypertrophic paralysis is a disease of early life, and consists essentially in a great increase of the interfibrillar connective tissue and fat, attended with simple atrophy of the muscle fibres. It is characterised by muscular wasting and increasing paralysis, and in typical cases by apparent hypertrophy of the muscles of the calves and gluteal regions.

The *cause* of the disease is obscure. In many cases it is undoubtedly hereditary, and occurs in several members of the same family. It is much more common in boys than in girls, and when inherited descends through the female line.

Pathology.—Whether the disease should be regarded as one essentially of the muscles, or the condition of the muscles as secondary to a lesion of the spinal cord, is still a disputed point, as opportunities for examining the cord have been few. The muscles in the early stages shew a great increase of the interstitial connective tissue and infiltration with fat, whilst in the later stages the fibres are found to have undergone atrophy, and to be more or less completely replaced by fat. The muscles first affected are usually those of the lower extremity, especially of the calf and buttock. Later all the voluntary muscles may be implicated, though the hypertrophic changes in these are seldom so marked.

Symptoms.—The onset of the disease is very

gradual. The child is unsteady on its feet, stumbles in walking, and readily falls. Later, as the extensor muscles of the knees and extensors and flexors of the hips become more affected, equilibrium in the upright position is maintained with difficulty. He stands with his feet far apart, so as to widen his base of support, his heels frequently drawn up from the ground by the contraction of the muscles of the calves, and his shoulders carried backwards, and the lower part of the spine in consequence thrown into a state of lordosis. The lordosis disappears on sitting, and apparently depends on the tilting forwards of the pelvis, due to the weakness of the hamstring muscles. In walking, the body is swayed from side to side in order to bring the centre of gravity at each step well over the leg that is on the ground. Rising from the recumbent position is difficult. He first turns on his face, then gets on his hands and knees, and then, extending his knees, places his hands on them, and then higher and higher up the thighs, pushing his body up by these means; "climbing the thighs," as it has been called. If the child is seen during the hypertrophic stage, the muscles of the calf, and probably those of the buttock and loin, are found enlarged. The enlarged muscles feel firm and hard, but on testing them with the faradic current their motor power is found diminished; and if a small piece of muscle is removed by Leech's trocar it will show the characteristic pathological changes. In rare instances the pseudo-hypertrophic change has been observed in all the muscles; but, as a rule, it is limited to those mentioned, the other muscles, especially the lower portion of the pectoralis major and latissimus dorsi, appearing wasted. The patellar reflex is at first diminished, and is later absent. The intellect is often weak, but at other times unaffected. The disease is very chronic in its course, and is attended in its later stages by contraction and distortion. The patients

usually die of exhaustion or from the respiratory muscles becoming affected.

Treatment.—Shampooing and faradisation in the earlier stages may be useful; in the later stages nothing has been of any avail.

Ossification of muscle may occur as the result of chronic irritation or inflammation. The osseous material, which has the structure of normal bone, is deposited in the proliferating connective tissue between the muscle fibres, causing the latter to atrophy. Examples of ossification are occasionally met with in the adductor muscles in persons who ride a great deal (rider's bone), and it was formerly not uncommon in the deltoid muscle of soldiers, as the result of shouldering arms (the drill bone). I have seen it in the rectus in cases of Charcot's disease of the hip; and Abernethy relates the case of a boy in whom bone was constantly developed in the muscles after a blow or other injury. Specimens of ossification of the muscles of the back, and of the vastus internus, are to be found in various museums. Blisters, with the internal use of mercury or iodide of potassium, appear to have given relief in some instances.

Tumours.—Primary tumours in muscle are rare; but fatty, fibrous, myxomatous, and more rarely enchondromatous and sarcomatous growths have all been met with. Blood and hydatid cysts are of more frequent occurrence, and syphilitic gummata are particularly common. Secondary growths are more often met with, the muscles, in common with the other tissues, being not infrequently affected in the general dissemination of carcinomatous and sarcomatous growths. Muscle may, of course, also be involved in the extension of epitheliomata from the skin or mucous membrane, and in sarcomata growing from the periosteum or bone.

Tendons.

Wounds.—The tendons perhaps most frequently wounded are those of the flexors and extensors of the fingers. They should be carefully united by animal sutures, kangaroo tail tendon being one of the best, and the parts placed at rest in such a position as to approximate the divided ends. When the injury has been overlooked, or union fails, the divided ends, which are often widely separated by muscular contraction, become adherent to the sheath and surrounding tissues, and the function of the muscle is impaired or lost. When the patient is young, and the local and general conditions are favourable for operation, an incision should be made over the cicatrix of the former wound, the ends of the divided tendon searched for, freed from adhesions, refreshed by shaving off the last half inch of each obliquely in opposite directions so as to bring them together splice-wise, and sutured as in a recent wound. These operations, though often disappointing, are sometimes attended with very brilliant results, as in a case recently under the care of my colleague, Mr. Willett, where, after suture of both the flexor sublimis and profundus tendons in the palm, a perfectly movable finger was obtained. Where, however, the patient is old, or of a broken-down constitution, or where there is evidence of extensive destruction or of adhesion of the tendon, little can be expected from suture, and in the case of stiff finger amputation is then attended with less risk. Where a considerable portion of tendon has been lost, attempts have recently been made by Herr Gluck to restore the lost part by uniting the divided ends with a leash of catgut, on the supposition that this will become organised. He claims successful results.

Rupture.—Subcutaneous rupture of tendons may occur during some sudden or involuntary action of the

muscles, and is not an uncommon accident in men beyond the middle period of life. It is most frequent in the plantaris, and tendo Achillis, and long tendon of the biceps. The rupture is often attended with an audible snap, and with a sensation to the patient of having been struck, followed, in the case of the plantaris or Achilles tendon, by lameness or inability to walk, and some local bruising and extravasation. After rupture of the long tendon of the biceps the short head contracts into a hard lump on putting the muscle into action, whilst a deficiency is felt in the situation of the long head. Rupture of the inner head is said generally to follow.

Treatment.—The parts should be placed at rest in such a position as to approximate the ruptured ends as much as possible. In the case of the plantaris or tendo Achillis, the foot should be fixed in full extension in plaster of Paris, and the leg flexed upon the thigh for a few days to relax the calf muscles. The treatment of ruptured biceps has not hitherto been very successful. In an otherwise healthy subject an attempt might be made to unite it by suture should it appear possible to reach the ruptured tendon without opening the shoulder joint.

The *method of union of a tendon* when ruptured subcutaneously is similar to that which occurs after tenotomy. A small cell exudation is formed between the divided ends, and is converted into fibrous tissue, which ultimately cannot be distinguished from the rest of the tendon.

Dislocation of a tendon from its sheath or groove, popularly known as a rick, is not an uncommon accident, though one often overlooked. It is most liable to occur to the tibialis posticus and the peronei where they pass behind the ankle, the long tendon of the biceps as it lies in the bicipital groove, the tendons in the fore-arm, and the small muscles of the back and

of the neck. It is usually due to a sudden twist or a strain, and is attended by pain and partial or complete loss of voluntary movement of the affected muscle, and consequently by lameness, or stiffness of the back or neck, etc., according to its situation. On examination, the displaced tendon may often be felt, but is liable to become obscured by swelling and ecchymosis.

Treatment.—A dislocated tendon, though readily reduced by manipulation, is difficult to keep in place. A pad and bandage should be applied, and the part in the case of the ankle or wrist placed in a well-fitting plaster of Paris splint. To retain the tibialis posticus or peronei in their place, an anklet with a properly arranged pad must subsequently be worn, and it may even be necessary to divide the tendon, or to pass a tenotome into the sheath for the purpose of fixing the tendon to the sheath by inflammatory adhesion.

Teno-synovitis, or inflammation of sheaths of tendons, is most frequently met with in the subacute form and in the extensors of the thumb and wrist, but it may occur in the tendons about the ankle, in the long tendon of the biceps, etc. It is usually the result of excessive exertion, and is attended by a localised swelling over the affected tendons, which is painful on pressure and movement, and gives when grasped during action of the part a characteristic creaking or crepitation. The inflammation is at times more acute, and may terminate in suppuration ; or if neglected may become chronic, and last for many weeks or months.

Treatment.—The part should be placed at rest on a splint, or a plaster of Paris or a Martin's bandage may be applied. When more acute a few leeches or hot fomentations, or if preferred an ice bag or cold lotions, may be necessary. If pus forms, free incisions should be made, followed by passive movements to prevent adhesions between the tendon and the sheath. When chronic, blisters, painting with iodine, strapping with

ammoniacum and mercury plaister, or Scott's dressing followed by elastic support, should be tried.

Paronychia tendinosa is an acute septic inflammation of the sheath of a tendon, and constitutes one of the varieties of whitlow. It is most common in the thumb or one of the fingers, but is occasionally seen in the toes. It is generally due to a poisoned wound, but it may follow a mere scratch or prick of the part in a person out of health, in whom, moreover, it may occur spontaneously. The inflammation, which is of an erysipelatous and septic character, may begin in the sheath of the tendon itself, or, as is more commonly the case, in the tissues superficial to it, or in the periosteum covering the phalanx. As soon as the sheath is involved serious consequences will follow if a timely incision to relieve tension is not made. Thus, in consequence of the unyielding nature of the fibrous tissue forming the sheath, the blood-vessels of the tendon may be strangled by the inflammatory effusion, and the tendon die, whilst the inflammation may extend into the palm, and under the annular ligament to the muscular planes of the fore-arm. When the periosteum is attacked, necrosis of the phalanx and destruction of one or more phalangeal joints, or even of the wrist joint, may occur.

Symptoms.—There is intense pain, often shooting up the fore-arm, hardness, throbbing, and acute tenderness on pressure in the affected finger, and later, in the palm; but fluctuation on account of the tenseness is not usually present. If allowed to run its course, the back of the finger and hand becomes red, swollen, and œdematous, and the palm infiltrated and tense; an erysipelatous blush, accompanied by œdema, extends up the fore-arm along the course of the lymphatics, whilst the lymphatic glands become tender and enlarged. Severe constitutional disturbance is often present, and the patient is greatly exhausted from

pain and want of sleep, and may even succumb to blood poisoning or septicæmia.

Treatment.—The surgeon should not wait for fluctuation, but as soon as there is hardness and throbbing pain, should make a free incision in the middle line of the finger extending into the sheath. In slighter cases, where the inflammation is superficial, the sheath should not be opened. The hand should be then placed on a splint, well raised by a sling, and a large poultice, or some hot moist antiseptic dressing, if preferred, applied. In severe cases nothing will be found to give greater relief than placing the hand and forearm in the arm bath for several hours, the temperature of the water being kept up the while. Notwithstanding this, if suppuration ensues in the palm, back of the hand, or fore-arm, early and free incisions are imperative. Dead bone must be removed when loose, and in severe neglected cases amputation may be necessary to save the patient's life. A saline or calomel purge is usually required at the onset, with opium in some form to relieve the pain. After suppuration has occurred, a tonic and supporting treatment is called for. Passive exercises may be required for long periods after healing to prevent stiffening of the fingers or wrist.

Ganglion is a simple or compound cyst formed in connection with a tendon. A *simple ganglion* consists of a closed sac composed of fibrous tissue lined with pseudo-epithelium, and containing a clear gelatinous colloid material. The sac does not communicate with the interior of the sheath of the tendon, and consequently is non-adherent to the tendon. It is not known exactly how these ganglia are produced. They are variously ascribed to a protrusion of the synovial lining through the sheath, with subsequent obliteration of the neck of the pouch thus formed; to a cystic degeneration of the cells in the synovial

fringes; or to a dilatation of the subsynovial follicles described by Joselin. They are most frequently met with on the extensor tendons at the back of the wrist; more rarely on the flexors, either in front of the wrist or near the web of the fingers, and on the tendons on the dorsum of the foot. They form smooth, globular, or sometimes lobulated, circumscribed, movable swellings, evidently connected with a tendon. They are semifluctuating, or tense, and almost solid-feeling, often translucent, and non-adherent to the skin. In size they vary from a hemp seed to a walnut, or even larger. They are generally painless, but give rise to a sensation of weakness in the wrist or fingers. Simple ganglia may be simulated by pouch-like protrusions of the synovial membranes of the carpus and tarsus, from which they may generally be distinguished by the pouches having deep connections, and having no apparent relation with any tendon, and by the synovial membrane appearing swelled in other places.

Treatment.—They should be broken by pressure of the thumbs or punctured with a tenotome, and their contents squeezed out, and firm pressure applied by means of a piece of sheet lead, a pad of lint, and a bandage. Should they refill, a second puncture should be made, the interior of the cyst scarified with the point of the tenotome, and pressure reapplied. This failing, a seton should be passed through the cyst wall, or the cyst dissected out.

A compound ganglion is a dilatation with thin serous fluid of the sheaths of several tendons, with complete or partial obliteration of the portions of the sheaths in contact. The sac generally becomes slightly thickened, and soft and velvety on its internal aspect, so that it resembles a mucous rather than a serous membrane. Melon-seed bodies, like those contained in some bursæ, are generally found in the interior.

Although it may occur in other situations, it is more common in connection with the flexor tendons as they pass under the annular ligament, and is then known as the *palmar bursal ganglion.* This generally forms an elongated swelling, constricted at its centre by the annular ligament, and extending into the palm and a variable distance up the fore-arm. Fluctuation can be obtained by pressing alternately above and below the annular ligament. Sometimes this ganglion involves the tendons of the thumb or little finger, or both.

Treatment.—Painting with liniment of iodine, blisters, and pressure should first be tried, although they seldom effect a cure, as all operative procedures are attended with much risk, and should only be undertaken as a last resource. Several methods of operating, as puncture, incision in the palm, division of the ligament, etc., have been advised. I have seen all attended with success. But, on the other hand, I have further seen all of them followed by diffuse suppuration, glueing together of the tendons, abscesses amongst the muscles of the fore-arm, and even by death. The operation that, in my opinion, is attended with the least danger and the best success, is an antiseptic incision both above and below the ligament, with evacuation of the melon-seed bodies, and free drainage. The hand and fore-arm should, of course, be placed on a splint.

Injuries and Diseases of Fasciæ.

Rupture.—The fascia, as that of the front wall of the abdomen, or that in front of the thigh, may be ruptured subcutaneously during some sudden or violent effort. Such a rent in the fascia is liable to remain ununited, allowing the muscles which it ought to confine to start forward during contraction. Protrusions of this nature through the abdominal fascia may

readily be mistaken for ventral hernia. Some form of elastic support should be applied.

Dupuytren's contraction, or contraction of the palmar fascia.—The cause of this affection is not very evident; it has been variously ascribed to gout and rheumatism, and to habits or occupations necessitating flexion of the fingers or mechanical pressure on the palm of the hand. It is more common in men than in women, and is said to occur more often in the upper and middle classes than in the lower.

Pathology.—The contraction occurs in that portion of the fascia which is prolonged on to the sheath of the flexor tendons and is inserted into the periosteum of the second phalanx. The bones, ligaments, and tendons are not affected.

Symptoms.—It generally begins in that part of the fascia which is continued on to the little or ring finger, whilst later it may involve that of the middle finger also, and in rare instances the fascia attached to all the fingers and even the thumb. The affected fingers are drawn gradually more and more downwards towards the palm, till they become, in severe cases, firmly fixed, and in contact with it. The contracted portions of the fascia form prominent ridges running from the affected fingers a variable distance into the palm, and can be made more tense on trying to straighten the fingers. Where the affection has existed some time the skin becomes adherent to the fascia and is thrown into transverse puckers. It may be distinguished from a contracted tendon by the latter forming a tense cord, which can be traced upwards under the annular ligament, and by the tissues of the palm appearing natural and not puckered. From arthritis deformans it may be diagnosed by the joints being unaffected.

Treatment.—In the incipient stages steps should be made to prevent the contraction increasing by the

use of some of the finger splints that have been invented for the purpose. When confirmed it is best treated by division and subsequent extension.

Much discussion has of late taken place as to whether a single division or multiple subcutaneous divisions of the fascia should be made. The writer, from an experience of both, has no hesitation in recommending the latter. But a very small tenotome must be used, and great care taken not to wound the skin. The hand and fore-arm should be afterwards placed on a splint, and the fingers gradually extended by elastic tension. (For contraction of the plantar fascia *see* Talipes, page 338.)

Diseases of Bursæ.

Bursæ, whether naturally existing as over the patella, or olecranon, or formed adventitiously from irritation or constant pressure on a part, as under a neglected corn or over the outer side of the foot in talipes varus, are liable to become acutely or chronically inflamed.

Acute bursitis, though apparently sometimes arising spontaneously, can generally be traced to a blow, fall, or other injury. It is attended with the usual signs of acute inflammation, and is very apt to run on into suppuration, and, if a timely incision is not made, to become diffuse, and of a phlegmonous character.

Treatment.—A few leeches, or an ice bag may be applied if seen early, but a free incision should be made as soon as there is any evidence of suppuration.

Chronic bursitis.—Chronic inflammation may give rise to several different pathological conditions, in all of which the bursæ are more or less enlarged and generally contain serous fluid. (1) Their walls are usually but slightly, if at all, thickened, and the fluid is merely an increase of the normal

bursal secretion. They then appear as more or less globular, fluctuating, tense, and sometimes flaccid swellings, and when superficial may be translucent. (2) In other cases their walls become distinctly thickened, whilst small, flattened, sharp-edged, ovoid, or sometimes irregularly shaped masses of fibrin known as *melon-seed bodies*, are found floating in a serous or dark-coloured fluid in their interior. The formation of these bodies has been attributed to the moulding of fibrinous deposits by constant movement, to the breaking-off of thickened synovial fringes lining the bursa, and to changes in blood which may have been extravasated into the interior of the bursa. Again, in place of melon-seed bodies, or together with them, fibrous cords may be found stretching across the cavity. The presence of melon-seed bodies may often be detected by the crackling sensation they communicate to the touch when the bursa is handled. (3) The walls may become greatly thickened from inflammatory infiltration, and probably in part from the concentric deposit of fibrin in their interior. A small central cavity usually remains, but in some instances they become solid throughout. In either case they give rise to a firm non-elastic solid-feeling tumour, and are often productive of great inconvenience.

The *treatment* will necessarily somewhat vary in detail according to the situation of the bursa. (*See* Diseases of Special Bursæ.) In simple enlargement, painting with tincture or liniment of iodine, or firm and equable pressure, will often disperse them. If this fails they should be punctured with a small trocar and the fluid evacuated, any melon-seed bodies contained in them squeezed out, and pressure applied. When great thickening of the walls has occurred, or the bursa has become solid, the only treatment is to dissect it out.

Diseases of Special Bursæ.

The bursa patellæ is, of all the bursæ, the one most often affected. Chronic enlargement, and, somewhat less frequently, acute inflammation, are very often met with; and from the frequency with which they occur in housemaids and others who have much kneeling, are known as the housemaid's knee. When chronically enlarged, the bursa appears as a prominent tumour in front of the patella and ligamentum patellæ, tense, flaccid or solid to the touch, according to the degree of distension and condition of its walls. When acutely inflamed it is liable to be mistaken for disease of the knee joint, the more so should the inflammation, as is sometimes the case, become diffuse and burrow around the joint under the expansion of the vasti. In the one, however, the patella will be behind the swelling, whilst in the other it will be in front of it.

Treatment.—In simple enlargement, should painting with iodine or pressure fail, the bursa should be punctured, the fluid let out, and the joint firmly strapped and placed on a back splint for a few days. When solid or much thickened, a vertical incision should be made over it and the bursa dissected out. As the capsule of the joint is very thin, and may be easily opened, care must be taken during the dissection to hold the knife close to the bursa, and not to drag the tissues too forward. Acute inflammation should be treated on the general principles already indicated. Should suppuration occur, a free vertical incision should be made over the centre of the patella; or, if the suppuration has become diffuse, two lateral incisions will ensure a better drain.

Bursa over the olecranon, called the miner's bursa from the frequency with which it is enlarged in miners, is particularly apt, after a blow or fall upon

the elbow, to become acutely inflamed. The inflammation is generally of a severe phlegmonous character, and extends a considerable distance above and below the back of the elbow joint, for disease of which it may be mistaken. The freedom of the joint in front, and the presence of a soft spot over the situation of the olecranon, are points which serve for the diagnosis. Free incisions should be made as soon as suppuration occurs, and the arm put at rest on an angular splint. Necrosis of a small portion of the olecranon is not an uncommon result. The dead bone should be removed when loose, great care being taken not to injure the elbow joint.

The bursa beneath the semimembranosus frequently becomes enlarged, giving rise to a tense or semifluctuating, and usually globular or ovoid swelling in the popliteal space. The absence of pulsation and of signs of inflammation, and the facts that the inner hamstring tendons can be traced over it, and that it becomes flaccid or disappears on flexing the knee, should prevent it being mistaken for other swellings in this region. Painting with iodine, firm strapping, or blisters will usually disperse it. Should these fail, puncture or antiseptic incision must be resorted to, operations, however, that should never be undertaken lightly, as the bursa often communicates with the knee joint.

The bursa over the tuber ischii is apt to become chronically enlarged, and its walls thickened, in persons whose occupations necessitate long sitting, and is then known as the coachman's or weaver's bottom. It is usually a source of great annoyance, and generally requires dissecting out.

The bursa over the great trochanter may, when enlarged and inflamed, simulate hip disease. It may be distinguished from it by the absence of the characteristic deformity of the latter affection and of

dead bone or any communication with the joint on opening the inflamed bursa.

The bursa under the tendon of the psoas, when enlarged, produces a deep-seated, fluctuating swelling in the groin. It may be mistaken for a psoas abscess or an aneurism, but the absence of spinal disease and signs of suppuration in the one case, and the fact that the artery is above the swelling in the other, should generally serve to distinguish them. It should be remembered that the bursa may communicate with the hip joint. (For bunion *see* Hallux valgus.)

VI. ORTHOPÆDIC SURGERY.

W. J. Walsham.

Wry Neck.

Wry neck or torticollis is a distortion produced by the contraction chiefly of the sterno-mastoid, and to a less extent of the trapezius and scalene muscles. A somewhat similar distortion may be produced by strumous and rheumatic disease of the cervical vertebræ, or by cicatricial contraction following burns or sloughing of the neck, or by paralysis of certain muscles. Such, however, are described in the articles on Diseases of the Spine, etc.

Causes.—Wry neck may be congenital or acquired. When congenital, it has been attributed to disease of the nervous system producing a spastic contraction of the affected muscles, to a malformation in utero, or to some injury of the neck inflicted at birth. The acquired form may be the result of the head having been held for a long time in a distorted position, as from stiff neck after cold or injury, or from inflammation of the cervical glands after scarlet fever, etc.; or it may be the result of hysteria, or of spasm of the muscles due to irritation of the spinal accessory nerve from some central nerve affection.

Pathology.—When the deformity is of some standing the ligaments are shortened, and the intervertebral cartilages compressed on the affected side; whilst in severe cases the bodies of the cervical vertebræ undergo rotation and slight lateral compression, and their articular processes are altered in shape and direction. The affected muscles undergo more or less fibrous degeneration.

Symptoms.—The head, supposing the right sterno-mastoid to be affected, is drawn forwards and towards the right shoulder, and at the same time rotated so that the chin points to the left. The left side of the neck is unnaturally convex, the right unnaturally concave, whilst the mastoid on that side stands out prominently, and both the sternal and clavicular portions of it can be felt. The features on the affected side are, in the congenital form, markedly smaller than on the other. In severe and long-standing cases slight elevation of the right shoulder and scapula, and some lateral curvature of the dorsal spine, are generally present.

The *diagnosis* is usually quite easy. From cervical caries, wry neck may be distinguished by the absence of the characteristic signs of the former, *i.e.* pain on movement and on percussing the head or vertebræ, rigidity and thickening, the patient's inability or unwillingness to rotate his head, and the tendency of the chin to drop forward. It is also important to diagnose the spasmodic and hysterical from the non-spasmodic and congenital. In the non-spasmodic the sterno-mastoid becomes tense on trying to straighten the head, in the spasmodic it gradually yields; in the non-spasmodic it becomes relaxed on bending the head towards the affected side, but in the spasmodic contracted. The history will further distinguish the congenital from the other forms. In the hysterical there will be other signs of hysteria, and the head can be straightened under chloroform.

Treatment.—In the congenital form, except in very slight cases in infants where exercises and manipulation alone may suffice, division of the sterno-mastoid is necessary. This, along with manipulation and exercises, will often be sufficient; but in severe cases instrumental treatment will also be required. The sterno-mastoid is best divided immediately above the

clavicle, as here it is chiefly tendinous, and further removed from the important structures which lie beneath it. A puncture should be made to the inner side of the tendon, and the sheath having been opened, a blunt director should be passed beneath the muscle and the division made towards the skin with a blunt-pointed tenotome guided by the director. Tense bands of contracted cervical fascia will now generally start up. These it is not safe to divide, but they may be made to yield by forcibly rotating the head and pressing upon them with the fingers. The puncture should be allowed to heal with the head in the deformed position, which it will do in two or three days. I usually put the patient through a series of exercises, consisting of various active and passive movements of the head and neck, for a fortnight or so before the operation, go on with them again when the wound has healed till the deformity has disappeared, and I advise their continuance for some time afterwards to prevent a relapse. In severer cases indiarubber bands, so arranged as to make traction in the desired direction, are used in the intervals between the exercises and at night. Where an instrument is necessary, I prefer the one shown in the accompanying woodcut (Fig. 69). The spasmodic form is often very intractable. When such remedies as bromide of potassium, Indian hemp, or conium have failed, the spinal accessory nerve may be stretched. It is readily found at the spot where it enters the sterno-mastoid, the posterior belly of the digastricus, under which it previously emerges, serving

Fig. 69.—Instrument for Wry Neck with Cog-wheel Action.

as a good guide to it. In this, as in the hysterical form, the sterno-mastoid should not be divided. I have obtained the best success in hysterical cases by placing the head in the straight position in a poroplastic collar, whilst giving hysterical remedies.

Scoliosis.

Scoliosis, or lateral curvature, is a complicated distortion in which the spine forms two or more lateral curves with their convexities in opposite directions; whilst the vertebræ involved in the curves are rotated on their vertical axis, so that the spinous processes turn to the concavity of the curves. It is more common in the young than in the old, in girls than in boys, and in the upper and middle classes than in the lower. Although most frequently met with in delicate and rapidly growing girls from fifteen to twenty-one, wanting in general muscular strength, it is occasionally seen in those who are strong, robust, and country-bred. It may also occur as one of the complications of rickets, and as the result of the falling in of one side of the chest consequent upon contraction following empyema, and in very rare instances as a congenital deformity.

Causes.—When the normal spine is inclined laterally, the pressure on the intervertebral cartilages and articular processes is increased on one side and diminished on the other. If this unequal pressure is continued for long periods, the articular cartilages under certain conditions will remain permanently compressed, while the articular processes become altered in direction and shape; in this way a permanent curve either to the right or to the left may be produced. Any circumstance, therefore, that causes the spine to incline for long periods to one or other side may be regarded as the exciting cause of lateral curvature; but it must not be lost sight of that

for the exciting causes to become operative, certain predisposing conditions appear to be necessary. These may be summed up as want of tone in the muscles and ligaments, or structural weakness of the bones such as may be induced by (1) heredity, (2) general debility, (3) the strumous diathesis, (4) rickets, (5) rapid growth, etc. The exciting causes may be classed as :

1. *Any condition causing permanent or habitual obliquity of the pelvis*, and the consequent throwing of the spine over to one side, such as a natural inequality in the length of the legs, knock knee, flat foot, congenital dislocation of the hip, use of a wooden leg, habit of standing on one leg, sitting cross-legged, etc.

2. *A one-sided position of the body* in sitting or lying down, or induced by following certain employments such as nursing a child, carrying heavy weights, etc.

3. *Contraction of one side of the thorax* following empyema, etc.

4. *Unilateral contractions of the spinal muscles* induced by paralysis of the opposing muscles.

There are various other theories as to the cause of lateral curvature, of which space will not permit the discussion, such as contraction of the spinal muscles on one side induced either by disease of the nervous system or by debility of the muscles on the opposite side, unequal contraction of the serratus magnus, etc.

Pathology.—In a typical example (*see* Fig. 70) the spine presents a double curvature, an upper dorsal and a lower lumbar, or, more correctly speaking, a dorso-lumbar. The dorsal has generally its convexity to the right, the lumbar its convexity to the left. The curvature which depends directly upon the exciting cause is called the primary; and the other which forms in the opposite direction to counterbalance the loss of equilibrium occasioned by the first,

the secondary or compensating. Either the dorsal or the lumbar may be the primary curve, and *vice versâ*. Less commonly the spine forms an apparently single curve, with the convexity either to the right or to the left; but in such cases there is always a slight compensating curve above and below, although these may not be observed externally. In other instances there may be four or even five curves duly compensating each other. The intervertebral cartilages, and to a lesser extent the bodies of the vertebræ involved in the curve, are compressed wedge-wise, the base of the wedge looking towards the convexity of the curve; whilst the articular processes are contracted and flattened on the concave side and elongated on the convex. In addition to the lateral deviation, the vertebræ forming the curves are rotated on their vertical axis, so that the front of the bodies looks towards the convexity, and the apices of the spinous processes towards the concavity of the curve. As a consequence of this rotation, although there may be

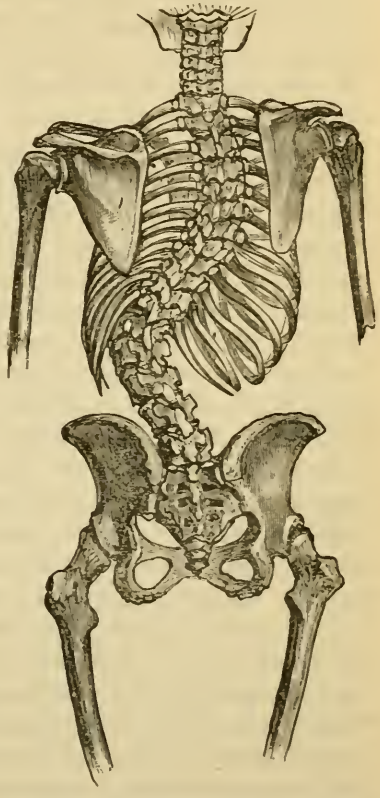

Fig. 70.—Lateral Curvature of the Spine. (From a specimen in St. Bartholomew's Hospital Museum.)

considerable lateral deviation of the bodies of the vertebræ, the apices of the spinous processes may be out little deflected from the middle line. The cause of this rotation has been variously explained. The theory which has perhaps found most favour, and to which only space will permit of reference, is that of Dr. Judson, of New York. "It is based on the fact that the posterior portion of the vertebral column, being a part of the dorsal parietes of the chest and abdomen, is confined in the median plane of the trunk, whilst the anterior portion of the column projecting into the thorax and abdominal cavities, and devoid of lateral attachments, is at liberty to, and physiologically does, move to the right and left of the median plane." As a result of the lateral compression and of the rotation of the vertebræ the transverse processes and ribs on the convex side are abnormally separated from one another and are carried backwards, whilst those on the concave side are closer together than natural and are carried forwards. The ribs, moreover, on the convex side are more horizontal than natural, and their angles form a hump in the dorsal region and cause the scapula to be raised and to project, while those on the concave side run more obliquely than natural, so that in severe cases they may be in contact with the iliac crest. There is thus much distortion of the thorax and undue prominence of the left breast. The pelvis, except in cases of rickety curvature, is not, as a rule, deformed, although in severe lumbar curvature it may be obliquely placed. Of the condition of the muscles in the earlier stages very little is known; in the later they have been found atrophied and undergoing fatty degeneration.

Symptoms.—The incipient stages of lateral curvature are frequently overlooked, and it is often not until it has become well marked and permanent

that the surgeon is consulted. Ofttimes the patient is brought to him for the shoulder or hip growing out, for round shoulders, or pain in the back, the parents perhaps declaring, if the question is asked, that the spine is quite straight. In such cases, and whenever there is a suspicion of lateral curvature, a thorough examination in drill posture, with the back fully exposed, should be made. In the earlier stages there may be but little deviation of the apices of the spinous processes, and what little there is may be made to disappear on suspending the patient or placing him in the prone position. There may be a slight projection of one scapula, however, or an apparent prominence of one iliac crest, or it may be a mere want of symmetry on the two sides of the spine, which may best be detected by placing the patient on a low seat and looking down the back from above, whilst along with this there will usually be more or less obliteration of the normal lumbar curve and a general tendency to stoop. In severer cases the deformity will generally be unmistakable, although the amount of deviation of the spinous processes, and prominence of the scapula and iliac crest will vary considerably, according to the character of the curve. In the common form, in which there is a longer dorsal curve with its convexity to the right, and a shorter lumbar with its convexity to the left, the right shoulder is generally elevated, and the angle of the right scapula and right crest of the ilium and left breast are prominent, whilst the backward rotation of the lumbar transverse processes on the left side cause the lumbar muscles to protrude and give a greater sense of resistance on pressing on this side of the spine. In the long and apparently single curve the deformity is often extreme. The ribs on the convex side project prominently backwards and form a hump in the dorsal region, and cause great elevation of the corresponding

shoulder and projection of the scapula, whilst those on the left side are huddled together and depressed, in some instances overlapping the crest of the ilium. At times the single curve is confined chiefly to the lumbar region; the prominence of the crest of the ilium on the concave side, and the backward rotation of the lumbar transverse processes and the consequent projection of the spinal muscles, are then the most marked feature; whilst at other times the curve is limited to the upper dorsal region, the chief characters then being the projection of the scapula on the convex side and the prominence of the trapezius, which may form an apparent tumour and give, as pointed out by Mr. Adams, a doubtful sense of fluctuation.

Diagnosis.—Lateral curvature may have to be distinguished from hysteria and from caries of the vertebræ attended with lateral instead of angular deviation. In hysteria there is no rotation, and the curve, although apparently permanent, will generally disappear on assuming the diving position and bending the back with the knees straight till the fingers touch the ground. Other evidences of hysteria will also commonly be detected, but if any doubt remains an anæsthetic should be given. In caries there is also no rotation; and pain will be elicited on motion, or on gently percussing the spine or tapping the head or shoulders. (*See* also Caries; Art. IX., vol. ii.)

Treatment.—The treatment must necessarily vary according to the severity and nature of the deformity. When there is evidence of general and muscular debility the general health and muscular tone should be improved by appropriate remedies, avoidance of late hours, crowded assemblies, and the like. The exciting causes of the deformity must be sought for, and, if possible, removed. Thus, all occupations necessitating one-sided positions, bad habits of sitting

or standing, carrying heavy weights, etc., should be avoided or given up. When there is flat foot or knock knee these should be remedied ; where one leg is shorter than the other, a boot with a high sole must be worn. These means, when combined with a judicious selection

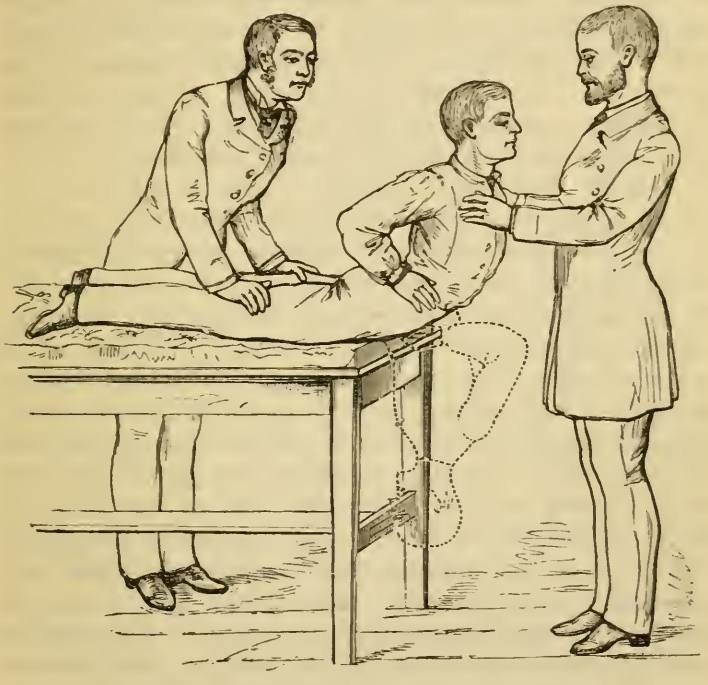

Fig. 71.—Exercises for Lateral Curvature.

of muscular exercises and partial recumbency, will generally be sufficient in slight cases to cure or greatly lessen the curvature. In severer cases the degree of improvement will be proportionate to the amount of osseous deformity ; whilst where there is much rigidity and confirmed structural change little or no improvement must be expected, and it will generally be found necessary, at least in hospital patients, to employ, in

addition to exercises, some form of mechanical support to prevent the curves from getting worse, to relieve pain when present, and to improve the outward appearance. The exercises should be directed both to strengthening the spinal muscles generally, and those in particular which tend to correct the curves. Amongst the former may be mentioned swinging by the hands from a bar, forcibly stretching an indiarubber cord attached to the floor, the use of dumb-bells, chest expanders, the extension motions of drilling, etc. An excellent exercise, which of late has been advocated by Dr. Busch in Germany, and Mr. Roth in this country, is to bring the patient's body over the end of a couch or table, and then, whilst he is prevented from falling by an assistant holding the legs, he is instructed to alternately flex and extend the body at the hip, whilst the surgeon resists his efforts (Fig. 71). For strengthening those muscles in particular that tend to straighten the curve, the back should be manipulated till that posture is found in which the curves are the least marked. In this position the patient can only hold himself by muscular action, and at first for only short periods at a time. By frequently practising this posture the muscles thus brought into play are gradually strengthened, till at last the improved position is maintained without effort. For further strengthening these muscles, Mr. Roth advises that the patient should exercise whilst in this improved position, especially advocating the movements above described. Dr. Busch, for this purpose, recommends that whilst the patient is thus supported over the end of the table the surgeon should make forcible pressure with his hand alternately in the dorsal and lumbar curve, at the same time bending the body to the right and left respectively.

Another device, especially indicated in lumbar curvature, is to place the patient, as recommended by

M. Bouvier and later by Mr. Barwell, on a seat raised several inches on the side corresponding to the convexity of the lumbar curve; the tilting of the pelvis thus produced, when the patient holds himself upright, counteracts the curves by its tendency to produce others in the opposite direction. A similar effect may be obtained by placing a high sole on the boot, and during riding by sitting on the off side of the saddle. None of these exercises should be carried to the extent of exhaustion, and rest on the back for half an hour to an hour should be taken after them. The back should be further supported by the use of a reclining chair, a good substitute for which may be made by raising the front legs of an ordinary chair on two bricks. Where there is much stooping my elastic brace (*see* Fig. 72) will be found useful, but should only be worn a few hours a day. At night time the patient should sleep on the side opposite to the dorsal curve; or on a Wolff's suspensory cradle.

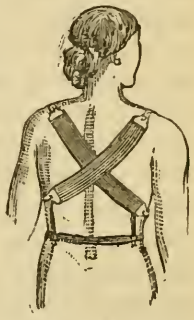

Fig. 72.—Walsham's Solid Rubber Shoulder Brace.

In the advanced cases, where a spinal support is thought necessary, a poro-plastic felt jacket or plaster of Paris case applied during suspension may be used; or, if a steel instrument is preferred, that known as Baker's stays, Chance's support, or one of the many other forms without arm crutches may be adopted.

Antero-posterior Curvature of the Spine.

This term is generally restricted to those cases in which the spine is bent either in a backward or forward direction, as a result of unequal compression of the intervertebral cartilages. The antero-posterior curvature of the spine depending upon disease either

of the cartilages or of the vertebræ is known as angular curvature, and is described under that head in the Article on Diseases of the Spine. When the curvature is convex forwards it is called lordosis; when convex backwards, kyphosis.

Lordosis.—Incurvation, or a curving of the spine with the convexity forwards, should be regarded as a symptom rather than an actual disease. In the lumbar region, in which it is most common, and in the cervical region, it is merely an increase of the normal curve; in the dorsal region it is a reversal of it. In the *lumbar region* it sometimes appears to be hereditary; generally, however, it is there formed as a compensating curve to restore the equilibrium of the body when this is disturbed by the tilting forward of the pelvis, as in congenital dislocation of the hip, hip disease, rickets, etc. Or it may be formed as a compensating curve in caries with angular curvature in the dorsal region; or it may depend upon contraction of the psoas muscle, consequent upon inflammation or abscess in its substance. In the *cervical region* it is generally compensatory to occipito-atloid or atlo-axoid disease. In the *dorsal region* it is very rare, but occasionally occurs as a compensating curve to caries of the lower cervical, lower dorsal, or lumbar vertebræ, and sometimes in double lateral curvature. The treatment should rather be directed to the cure of the occasioning cause than to the removal of the lordosis, which in itself is not usually of a permanent nature.

Kyphosis.—Excurvation, or posterior curvature, is a general curving of the spine with the convexity backwards, or an exaggerated condition of the normal dorsal curve depending upon unequal compression of the intervertebral cartilages. It is often seen in infants and in delicate and rickety children who have been allowed to sit up too early or for too long

periods. In growing girls and lads it is brought on by slouching habits, and in older persons may be acquired by occupations necessitating stooping; hence its frequency in watchmakers, clerks, agricultural labourers, etc. It may also be induced by chronic bronchitis and chronic rheumatism. Sometimes it would appear to be hereditary. In infants the kyphotic curve is most marked in the lower dorsal region, where several of the spinous processes often appear preternaturally prominent. In boys and girls and in old people the curve chiefly affects the upper dorsal region, producing the round shoulders with which all are familiar. The point of chief interest is to distinguish between the comparatively harmless kyphotic curve and angular curvature depending upon caries of the vertebræ. In children and adults it is usually easy, but in rickety infants the surgeon is unable to apply the usual tests for caries, such as the behaviour of the spine in stooping or rising from the recumbent position in walking, jumping, etc.; and he is, moreover, liable to be misled by the acute tenderness and evident pain on handling that often occurs in rickets. If the infant is placed horizontally with its face downwards across the nurse's knees, and gently extended by the arms and legs, the rickety curve disappears or may become posteriorly concave, whilst the back may be more flexible than natural in its whole extent. In caries, on the other hand, the curvature remains, or is even increased, and the spine is rigid; the infant is, moreover, evidently uneasy in this position, and tries to resist the extension of the back by muscular action and drawing up of the legs. Other indications of rickets will also probably be present.

Treatment.—In the infant perfect recumbency should be enjoined, and such dietetic and hygienic measures taken as to restore the muscular tone, with appropriate remedies when there is evidence of rickets.

Local support to the back in the form of a moulded leather or poro-plastic jacket is recommended by high authorities. But I prefer trusting, as a rule, to recumbency. In growing lads and girls slouching habits should be corrected, and a system of muscular exercises instituted, combined, when there is debility, with periods of recumbency and attention to the general health. A spinal brace should also be worn for a few hours daily. In the confirmed kyphotic curve of old age treatment is of little avail.

CLUB HAND.

Several rare deformities of the hand, depending upon a contracted condition of the muscles or malformation or absence of some of the bones of the fore-arm and hand, have been included under this term, on the supposition that they were analogous to club foot. The most common of these deformities, perhaps, is that in which the radius and one or more of the bones of the carpus and the thumb are absent, the hand being fixed in the position of flexion and abduction. Space will not permit of a further account of these conditions, nor is this much to be regretted as they can have little or no interest for the practical surgeon.

TALIPES OR CLUB FOOT.

Five principal forms of club foot are described, talipes equinus, calcaneus, varus, valgus, and cavus. These forms of club foot may be variously combined, and are then spoken of as equino-varus, equino-valgus, calcaneo-valgus, etc.

Causes.—Club foot may be congenital or acquired. Various theories have been advanced to account for the congenital form. The chief of these are : (1) That it is due to a spastic muscular contraction consequent

upon some lesion of the nervous system, the bones being drawn into their abnormal position by the contraction of the muscles, and there fixed by adaptive shortening of the muscles and ligaments. No alteration, however, has as yet been discovered, either in the brain or spinal cord, to account for this so-called spastic contraction. (2) That it is due to malposition of the fœtus in utero, the bones being merely maintained in their faulty position by the adaptive shortening of the muscles and ligaments, and not drawn there by any active contraction of the muscles. (3) That it is due to a structural alteration in the form of the bones themselves. An alteration in the shape of the astragalus in congenital varus no doubt exists, but it appears as likely to be the result of the malformation as the cause of it. The congenital form, moreover, may occur in several members of the same family, and often appears to be hereditary.

The causes of acquired club foot are numerous. Of these, infantile paralysis is one of the most common, the deformity being then in part due to the drawing of the bones into the faulty position by the contraction of the muscles antagonistic to those paralysed, and in part to the superincumbent weight of the body tending more and more to increase the faulty position. The less common causes will be referred to under the heads of the different varieties.

The *symptoms* of club foot can better be discussed under each variety.

A few general remarks here on **treatment,** however, will prevent repetition when describing that appropriate to each. The general indications are, first to restore the deformed foot to the natural position, and then to retain it there until it shows no tendency to relapse and the functions of the joints and muscles have been, as far as possible, regained. For the first indication both operative and mechanical treatment

may be necessary ; for the second, mechanical supports and physiological after-treatment should be employed.

The *operative treatment* will, in by far the greater number of cases, be merely a subcutaneous division of certain tendons ; but in inveterate cases, where tenotomy and all other means have failed, some form of osteotomy of the tarsus becomes necessary.

Tenotomy is indicated where there is much rigidity, and the foot cannot be restored by manipulation to its natural position. Its object is to permanently lengthen the contracted tendon by the insertion of a piece of new material. This new material is formed from a small cell exudation, which, when the tendon is divided, is poured out from the divided ends, and is ultimately converted into fibrous tissue which cannot be distinguished by the naked eye from the rest of the tendon. Thus, from a quarter of an inch to an inch and a half, or even more, of new tendon may be produced according to the rapidity of the rate of extension afterwards employed. The tendon having been made tense by an assistant, the tenotome should be passed beneath it with its blade parallel to it. The tendon should now be relaxed whilst the edge of the tenotome is turned towards it, and then again made tense to facilitate its division, which is effected by cutting outwards towards the skin. The assistant should relax, the surgeon cease to cut, the moment the resistance of the tendon is felt to be overcome, so as not to pierce the skin and render the puncture an open wound. On removing the tenotome a dossil of oiled lint should be placed over the puncture and secured by a piece of strapping and a bandage, care being taken to prevent the entrance of air lest suppuration should ensue, and the tendon adhere to its sheath or fail to unite. It is usual to place the part in the deformed position on a splint or in some form of Scarpa's shoe, till the puncture has healed, before beginning mechanical extension. Many,

however, place the foot at once in its natural position in plaster of Paris; but in so doing a risk is run of the tendon not uniting, or of the uniting tissue remaining weak. Whilst using plaster of Paris, I place the foot in a slightly improved position only, so that the ends of the tendon are not sufficiently separated to endanger their union.

Tarsotomy.—Various operations having for their object the removal of certain bones or portions of bones from the tarsus, so as at once to restore the normal shape of the foot, have from time to time been practised. Of these may be mentioned Davy's operation, or the removal of a wedge-shaped piece of bone from the tarsus, and Lund's operation of excision of the astragalus. These operations have been followed with excellent results, but it cannot be too strongly urged that they should only be undertaken in inveterate cases, and not until all milder measures have failed.

Mechanical treatment aims at bringing the foot slowly into its natural position by overcoming the resistance of the contracted muscles and ligaments; or, where tenotomy has been previously done, by so regulating the amount of new tendon formed that the same result is obtained. The apparatus, perhaps, in most general use is some kind of Scarpa's shoe. This, in its simplest form, consists of a leather slipper, united to a leg iron and calf piece, and provided, opposite the ankle, with a joint which can be moved in the direction of flexion and extension by a cog-wheel, so that it can be made to correspond to the shape of the deformed foot. In this position it is strapped on, and then by a daily turn of the cog-wheel the foot is gradually brought into its natural position. But as equally good, if not better, results may be obtained by plaster of Paris, which, moreover, is much cheaper, I have of late treated all the suitable cases in the Orthopædic Department at St. Bartholomew's Hospital in

this way. If plaster of Paris is used, it should be applied once or twice a week, according to the ligamentous resistance and the amount of new tendon it is wished to produce. A cotton wool bandage should on each occasion be placed under the plaster.

The mechanical supports for maintaining the foot in the improved position will be described under each form of talipes.

Physiological after-treatment aims at restoring the proper movements of the joints and the functional activity of the muscles. It consists in active and passive exercises, shampooing, faradisation, hot and cold bathings, and last, but not least, the education of the child in the proper use of the foot in its restored position. Of course, in paralytic cases, where the muscles have undergone fatty change, the same good result cannot be expected, and in such a mechanical apparatus may have to be worn for life.

TALIPES EQUINUS.

In this form of club foot the heel is drawn up by the tendo Achillis, and the anterior part of the foot, in consequence, depressed. There is neither inversion nor eversion; when such occurs, the deformity is spoken of as equino-varus, or equino-valgus. Like other forms of talipes, equinus may be congenital or acquired. The congenital form is extremely rare; the causes of the acquired may be enumerated as: (1) Contraction of the muscles of the calf, due to (*a*) infantile paralysis of the anterior muscles; (*b*) extension of the foot for long periods, as from the weight of the bed clothes where the limb is confined on a splint. (2) Disease in or about the ankle joint. (3) Contraction of cicatrices following burns and wounds.

Morbid anatomy.—The os calcis is drawn up by the tendo Achillis, and the astragalus in consequence

half tilted out of its socket and fixed in the natural position of extension. The weight is thus transmitted through the heads of the metatarsal bones, which, with the anterior part of the tarsus, are bent backwards and downwards from the transverse tarsal joint, so that in severe cases they are nearly vertical in direction, and almost in a line with the bones of the leg; and are fixed in this position by the contraction of the plantar fascia and ligaments and short muscles of the sole. The whole foot, therefore, appears extended and shortened, and the sole unnaturally concave. The muscles of the calf and sole, and in some cases even the deep muscles of the leg are shortened, but not, as a rule, otherwise altered in structure. The muscles on the anterior aspect of the leg are, in paralytic cases, in various stages of fatty degeneration. The patient walks upon the balls of his toes, and with more or less fatigue and lameness; whilst if both feet are affected, he may be unable to walk at all or even to stand. In slight cases there may be no obvious deformity, except perhaps some increase in the concavity of the sole, but merely an inability to flex the foot beyond the right angle. In such cases, which are sometimes spoken of as *right-angled contraction of the tendo Achillis*, there is always lameness, on account of the limited extension at the ankle joint. It is easily detected by pressing the knee well back while the leg is extended. In paralytic cases, in consequence of want of power in the

Fig. 73. – Talipes Equinus from paralysis of the anterior muscles.

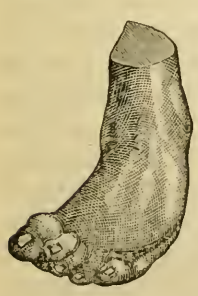

Fig. 74. — Talipes Equino-varus.

anterior muscles, the toes become flexed and carried backwards towards the sole at their metatarso-phalangeal joints (Fig. 73), instead of being extended as in ordinary equinus, or extended at these joints and flexed at their first interphalangeal joints, as they are in spasmodic cases. In extreme paralysis the whole foot may be carried backwards, so that the dorsum is placed upon the ground if the patient attempts to stand or walk. In such cases there is usually shortening of the limb and much wasting, whilst the skin is blue and cold. In old-standing cases much crippling is often present from the formation of corns over the metatarsal bones, whilst, as the result of the contraction being greater on the inner than on the outer side of the sole, an inward twist is given to the foot (equino-varus) (Fig. 74).

Treatment.—Tenotomy of the tendo Achillis is usually all that is required. But where there is much contraction of the sole the plantar fascia or any tense bands that may be felt should first be divided, and the foot placed with the sole straightened out as much as possible in plaster of Paris or in a Scarpa's shoe with a jointed sole-plate, by which means the anterior part of the foot can be lifted up. In a week or fortnight, or as soon as the sole is straight, the tendo Achillis, which has thus served to fix the os calcis while the contracted sole was being straightened out, may then be divided. The heel should now be gradually brought down by plaster of Paris, or an Adams', or some other form of Scarpa's shoe till the foot forms the same angle with the leg as on the unaffected side. The time required for this varies from a fortnight in the infant to six weeks in a paralytic case. If any varus coexists, it should, like the contraction of the sole, be cured before attacking the equinus. To prevent a relapse, a boot with double leg irons and free joint at the ankle should subsequently be worn during the

day, and a rectangular tin splint or a light Scarpa's shoe at night, or traction may be made upon the foot by means of an indiarubber band properly secured to the foot and calf. But, above all, physiological means should be persevered in (*see* page 342) till free movement of the ankle joint has been obtained, and the function of the atrophied muscles as much as possible restored. In paralytic cases the irons should have a stop-joint at the ankle, with a toe-raising spring to take the place of the paralysed muscles, and where the limb is much shortened the boot should have a correspondingly high sole. The irons, where the muscles of the thigh are also affected, should be carried above the knee, and the outer iron above the hip to the pelvis, where it is secured to a pelvic band. There should be a free joint at the hip, and a ring or flute-key catch at the knee in order to fix the knee during progression, and to allow it to be flexed on sitting down, or going up or down stairs.

Talipes Varus

is the most complicated form of club foot. By some it is spoken of as equino-varus, as there is undoubted drawing up of the heel as well as inversion of the foot. I, however, prefer, with Mr. Adams, to apply the simple term varus to the deformity under consideration, and to restrict the term equino-varus to those cases of true equinus in which there is a slight inward twist of the foot. Talipes varus, as thus understood, occurs most frequently as a congenital affection, and as such is by far the most common form of congenital club foot. It usually affects both feet, but it may be limited to one, or there may be varus of one foot and valgus of the other. It is often complicated by weakness of the knee joints, occasionally by rigidity of the knees or hips, and more rarely by other congenital abnormalities,

as deficiency in the length of the leg, spina bifida, club hand, etc.

Morbid anatomy. (*See* Fig. 75.)—The distortion may briefly be said to consist in extension of the foot at the ankle, and in the inversion and rotation of that part of the tarsus which is situated in front of the transverse tarsal joint. The length assigned to this article does not admit of a detailed account of the distortion. It must, therefore, suffice to say that the os calcis appears drawn upwards by the tendo Achillis, and the astragalus partially tilted out of the ankle joint, whilst the scaphoid and remaining bones of the tarsus appear drawn upwards and inwards by the tibialis anticus and posticus, so that the scaphoid is placed internal to the astragalus instead of in front of it, and its tuberosity in close contact with the internal malleolus. The ligaments on the inner side of the foot are shortened, those on the outer side elongated. The muscles, except in paralytic cases, in which they are found in various stages of fatty degeneration, are shortened, but otherwise healthy. The tendon of the tibialis anticus lies over the internal malleolus, instead of in front of it, whilst the tibialis posticus is displaced forwards, so that it lies midway between the anterior and posterior border of the leg, and on leaving the malleolus passes straight downwards to the scaphoid instead of pursuing its normal course. The altered relation of the other tendons is of less importance. In congenital cases the neck of the astragalus inclines more inwards than natural, so that the head looks forwards and inwards instead of forwards.

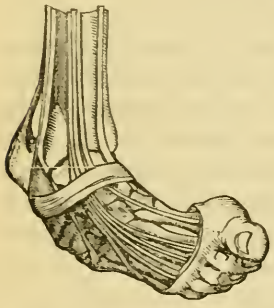

Fig. 75. — Talipes Varus, from a specimen in St. Bartholomew's Hospital Museum.

Symptoms.—In the congenital form in the infant, the anterior part of the foot is inverted, whilst the inner border is turned upwards, and the outer border downwards, so that the sole looks backwards and the dorsum forwards. In severe cases the inner border may be drawn into contact with the leg. The long axis of the foot is shortened and bent upon itself, so that the sole is unnaturally concave and the plantar fascia tense. The internal malleolus is obscured by the scaphoid, and the heel is drawn up, and is small and ill formed. In slight cases the foot can be turned into the natural position by the hand, but resumes its faulty shape when released. If the foot has been walked on the deformity is still further increased (Fig. 76). The sole then looks upwards as well as backwards, and the dorsum downwards as well as forwards, whilst the transverse arch is narrowed by the approximation of the fifth metatarsal bone to the first. The bones, moreover, become rigidly fixed in their deformed position by the adaptive shortening of the ligaments. In consequence of the narrowing of the transverse arch and the flexion of the foot at the transverse tarsal joint, a longitudinal and an oblique furrow are formed in the sole, and are considered by Mr. Adams as diagnostic of the congenital form. Along the outer border and on the dorsum of the foot the skin becomes thickened, whilst a bursa often forms beneath it, and is liable to become inflamed or to suppurate and leave an intractable ulcer. The *acquired form*, which is usually due to infantile paralysis, may generally be distinguished from the congenital by the history of the case, by the wasting, shortening, and coldness of the affected limb, by the general rounded

Fig. 76. — Talipes Varus in the Adult.

and smooth appearance of the foot, and by the absence of rigidity and of the furrows in the sole.

Treatment.—In very slight infantile cases, holding the foot in the natural position for certain periods during the day, and in slightly severer cases, similar manipulations combined with mechanical extension, will often suffice. But where there is much rigidity, tenotomy is generally necessary. This is best done when the child is about two months old, although for hospital patients, where the physiological after-treatment is apt to be neglected, it had better be delayed until the child is about ten months old, that is, till just before it is able to walk. In a severe case, the tibialis anticus and posticus, the tendo Achillis, and the plantar fascia, require division. Of these, the tibialis anticus and posticus should be divided first, leaving the tendo Achillis to act as a *point d'appui*, whilst the inversion of the foot is being overcome by mechanical means; and subsequently, at the end of a fortnight or three weeks, or as soon as the foot has been brought into a straight line with the leg, the tendo Achillis should be divided and the heel brought down. Where there is much contraction of the sole, the plantar fascia, or practically any tense bands that can be felt, should be divided after the tibials, but before the tendo Achillis. In some cases the inversion of the foot (the varus position) may be overcome by mechanical treatment alone, although the heel cannot thus be brought down. In such, the division of the tendo Achillis will suffice. The division of the tendo Achillis and plantar bands has already been discussed under equinus. In dealing with the tibials the anticus should be divided first, especially where it is much contracted. This is best done above the anterior annular ligament, the tenotome being passed close to the fibular side, so as to avoid injuring the anterior tibial artery. The tibialis posticus should be divided just above the internal

annular ligament. In the adult the posterior border of the tibia serves as a guide to it, but in a fat infant this cannot always be felt, and the puncture should then be made midway between the anterior and posterior border of the leg. The sheath having been opened by a sharp-pointed tenotome, the operation should be completed with a blunt-pointed one, to avoid pricking the posterior tibial artery. After the division of the tibialis posticus, the flexor longus digitorum may be severed, if desired, by passing the tenotome slightly deeper; not too deeply, however, lest the posterior tibial artery be wounded. Should this accident happen, which may be known by a slight spurt of blood and blanching of the foot, firm pressure must be applied, and no harm, as a rule, will ensue. After the division of the tibials the foot may either be placed in a slightly improved position in plaster of Paris, or on a tin varus splint in the deformed position for two or three days, until the punctures have healed. It may then be gradually brought into the straight line with the leg, either by reapplying the plaster every few days, or by daily bandaging it to the splint. If the latter is used, it should be placed alternately on the inner and outer side of the leg to avoid injurious pressure, and the bandage should be applied from above downwards, so as first to fix the leg and then to draw the foot to the splint. In either of these ways the inversion of the foot will generally be overcome in a fortnight or three weeks, and the tendo Achillis may then be divided as soon as the foot remains in a straight line with the leg on the removal of the plaster or splint, the heel being brought down either by plaster of Paris or by a Scarpa's shoe, as described in equinus. Some mechanical apparatus must be worn during the day, for at least twelve months, to prevent a relapse, and a rectangular tin splint, or a light Scarpa's shoe at night, especially when any tendency

to inversion remains. At the same time it is most important that the physiological means described at page 342 should be persevered in till the movements of the foot have been as much as possible regained. For the infant, the best mechanical apparatus is perhaps Mr. Adams' boot. It is provided with an outside leg iron and calf band, with a free joint at the ankle to allow of passive movements of extension and flexion being carried on during its use. For older children and adults, a boot with double leg irons, free joints at the ankle, and a strap passing across from the outer side of the boot over the inner iron is requisite. Where the whole leg tends to twist inwards at the knee joint from relaxation of the ligaments, the irons should be carried above the knee and the outer iron above the hip and secured to a pelvic girdle. In paralytic cases there should be a stop-joint at the ankle, and a toe-raising spring to counteract the tendency of the tendo Achillis to re-contract. When the muscles of the thigh are seriously affected, the joints at the knee must be fixed to permit of walking. This is best done by the ring or flute-key catch, which permits of the irons being bent when the patient wishes to sit down.

Relapsed varus is unfortunately too common, and this, perhaps, chiefly because the proper mechanical and physiological after-treatment is apt to be neglected. The incomplete division of the tendons, their division in a wrong order, the inflammatory adhesion of a tendon to its sheath, and in long-standing cases the shortening of the ligaments and adaptive growth of the bones in their malposition, all render a relapse liable to occur. The treatment of such cases is generally unsatisfactory. The mechanical and physiological means above described should first be tried. This failing, tenotomy must again be done, and as a last resource some form of tarsotomy. (*See* page 341.)

Talipes Calcaneus

may be congenital or acquired; but both forms are rare. The acquired may be due to infantile paralysis affecting the posterior muscles, non-union or too great separation of the ends of the tendo Achillis after rupture or division for talipes equinus, or contractions following burns or wounds on the front of the leg.

Symptoms.—In congenital cases both feet are generally affected; the anterior part of the foot is drawn up, often a little everted, and generally rigidly fixed in this position by the contraction of the extensor tendons. In the acquired cases due to infantile paralysis of the calf muscles the heel is placed first to the ground in walking; but there is no rigidity of the extensors, so that the foot is not drawn up towards the leg, and can be placed by the surgeon in the position of equinus. The anterior part of the foot, moreover, drops downwards from the transverse tarsal joint (*see* Fig. 77), and the tendo Achillis, instead of standing out tensely, runs as a flattened band close behind the ankle.

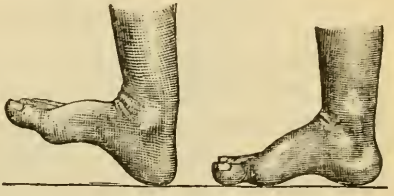

Fig. 77.—Talipes Calcaneus. The foot before and after section of the tendo Achillis.

Treatment. — In slight congenital cases manipulation and drawing down the foot will often suffice; this failing, the extensor tendons should be divided and the foot rectified by plaster of Paris or a Scarpa's shoe. In paralytic cases, a boot with double leg irons, a stop-joint at ankle, and toe-depressing spring should be worn, and faradisation, shampooing, etc., of the leg sedulously employed. Where any portions of the calf muscles, as shown by electrical tests, remain

unaffected by the paralysis, they may, to a great extent, regain their function by bringing them into use by shortening the elongated tendo Achillis. This may be done by removing half an inch or so of the tendon obliquely, splicing the divided ends, and retaining the foot in the equinus position in plaster of Paris till firm union is obtained. I have performed this operation in some half-a-dozen cases, and have seen it done by my colleague, Mr. Willett, in several others, with considerable improvement to the patient. In Fig. 77 the foot is represented before and after the shortening of the tendon.

TALIPES VALGUS, OR FLAT FOOT,

is characterised by a flattening of the longitudinal and transverse arches of the foot, and by more or less eversion of its anterior part. Though rare as a congenital, it is frequent as an acquired deformity, and would then appear to depend upon various causes. The chief of these are, perhaps, the yielding of the ligaments of the sole, and the relaxed condition of the muscles which normally support the plantar arches, in consequence of general debility and want of muscular tone, combined with long standing, carrying heavy weights, etc. Hence the frequency with which it occurs in growing underfed lads, in whom it is frequently associated with knock-knee, in waiters, housemaids, policemen, etc. Amongst other causes must be mentioned rheumatism (especially gonorrhœal), rickets, sprains or other injuries of the plantar ligaments, and paralysis of certain muscles of the leg.

Morbid anatomy.—The plantar fascia, calcaneo-scaphoid, and, to a lesser extent, the other ligaments of the sole, are elongated, and the bones on the inner side of the foot, instead of forming an arch, are depressed and in contact with the ground. At the same

time, the bones in front of the transverse tarsal joint are slightly everted, leaving the articular surface of the head of the astragalus exposed, and forming a prominence on the inner side of the foot. In severe cases, and usually in the congenital variety, the tuberosity of the os calcis is drawn upwards by the tendo Achillis, whilst the outer border of the foot is raised from the ground, and the whole of the bones in front of the transverse tarsal joint are drawn upwards towards the front of the leg by the anterior muscles, rendering the dorsum of the foot concave and the sole convex.

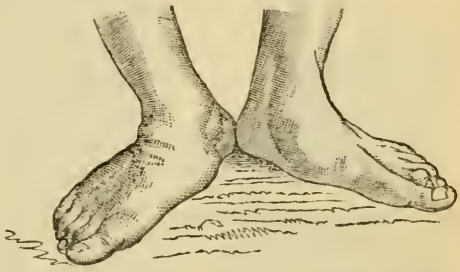

Fig. 78.—Talipes Valgus, or Flat Foot; 2nd degree.

Symptoms.—Pain in front of the instep, or about the insertion of the tibial or peroneal tendons, and often of a severe and crippling character, is generally present, and is always worse after a day's work. The foot looks broader and longer than natural (Fig. 78), the sole flat, its inner border in contact with the ground, whilst its anterior part appears slightly everted, especially in walking. The instep is low, the internal malleolus depressed, whilst two prominences, formed by the tuberosity of the scaphoid and the partly exposed head of the astragalus, appear on the inner side of the foot. In slight cases the natural symmetry of the foot is restored if the patient raises himself on tip-toe, or stands on the outer edge of the foot; whilst on manipulation there is no rigidity, and the two prominences can be made to disappear by gentle pressure. In severer cases the foot is rigidly fixed in its deformed condition, and the peronei stand

addition to exercises, some form of mechanical support to prevent the curves from getting worse, to relieve pain when present, and to improve the outward appearance. The exercises should be directed both to strengthening the spinal muscles generally, and those in particular which tend to correct the curves. Amongst the former may be mentioned swinging by the hands from a bar, forcibly stretching an indiarubber cord attached to the floor, the use of dumb-bells, chest expanders, the extension motions of drilling, etc. An excellent exercise, which of late has been advocated by Dr. Busch in Germany, and Mr. Roth in this country, is to bring the patient's body over the end of a couch or table, and then, whilst he is prevented from falling by an assistant holding the legs, he is instructed to alternately flex and extend the body at the hip, whilst the surgeon resists his efforts (Fig. 71). For strengthening those muscles in particular that tend to straighten the curve, the back should be manipulated till that posture is found in which the curves are the least marked. In this position the patient can only hold himself by muscular action, and at first for only short periods at a time. By frequently practising this posture the muscles thus brought into play are gradually strengthened, till at last the improved position is maintained without effort. For further strengthening these muscles, Mr. Roth advises that the patient should exercise whilst in this improved position, especially advocating the movements above described. Dr. Busch, for this purpose, recommends that whilst the patient is thus supported over the end of the table the surgeon should make forcible pressure with his hand alternately in the dorsal and lumbar curve, at the same time bending the body to the right and left respectively.

Another device, especially indicated in lumbar curvature, is to place the patient, as recommended by

M. Bouvier and later by Mr. Barwell, on a seat raised several inches on the side corresponding to the convexity of the lumbar curve; the tilting of the pelvis thus produced, when the patient holds himself upright, counteracts the curves by its tendency to produce others in the opposite direction. A similar effect may be obtained by placing a high sole on the boot, and during riding by sitting on the off side of the saddle. None of these exercises should be carried to the extent of exhaustion, and rest on the back for half an hour to an hour should be taken after them. The back should be further supported by the use of a reclining chair, a good substitute for which may be made by raising the front legs of an ordinary chair on two bricks. Where there is much stooping my elastic brace (*see* Fig. 72) will be found useful, but should only be worn a few hours a day. At night time the patient should sleep on the side opposite to the dorsal curve; or on a Wolff's suspensory cradle.

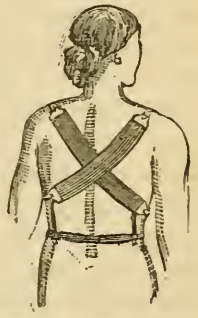

Fig. 72.—Walsham's Solid Rubber Shoulder Brace.

In the advanced cases, where a spinal support is thought necessary, a poro-plastic felt jacket or plaster of Paris case applied during suspension may be used; or, if a steel instrument is preferred, that known as Baker's stays, Chance's support, or one of the many other forms without arm crutches may be adopted.

Antero-posterior Curvature of the Spine.

This term is generally restricted to those cases in which the spine is bent either in a backward or forward direction, as a result of unequal compression of the intervertebral cartilages. The antero-posterior curvature of the spine depending upon disease either

interossei, but the exact pathology is hardly known. Division of the plantar fascia will sometimes suffice, but where the tendo Achillis is contracted it must subsequently be divided also. At times, however, tenotomy of the extensor, or even of the flexor tendons as well, may be necessary. A steel sole plate, with slots cut at the extremity, through which elastic straps pass to press down the toes, should be worn in the boot to prevent a relapse.

KNOCK-KNEE.

Genu valgum, or knock-knee, is a deformity in which, when the knees are extended and placed together, with the patellæ looking directly forwards, the legs, instead of being parallel to each other, diverge, so that the malleoli cannot be brought into contact. One or both knees may be affected, or there may be genu valgum on one side and genu varum on the other. Flat foot, curvature of the tibiæ and femora, and lateral curvature of the spine, are not infrequent concomitants.

Cause.—The affection occurs chiefly at two periods of life; in children between the second and the seventh year, and in growing lads, and less frequently girls, between the fourteenth and the eighteenth. At the former period it is generally the result of rickets, at the latter, of the carrying of heavy weights, long standing, and the like. The way in which these causes become operative has long been a source of dispute. Thus, by some the muscles, by others the ligaments, and by others the bones, are believed to be primarily at fault. That the biceps tendon and external lateral ligament are, in some instances, contracted and tense, that in others the internal ligament is elongated, allowing free lateral movement of the joint, and that in others again there is a marked elongation of the internal condyle of the femur, or uprising of

the inner tuberosity of the tibia, are undoubted facts, but it is open to question which is the primary lesion and which the secondary phenomenon. In all the rachitic cases, and in most of the others that I have seen, there has been an evident elongation of the internal condyle, and in some of these a contracted condition of the biceps tendon, and in others a relaxed internal lateral ligament; but in very few have I found a relaxed state of the ligament without obvious overgrowth of the bone. I am therefore inclined to regard the osseous as commonly the primary lesion, although I admit that in those rapid cases in which the deformity has been developed in a few months from excessive weight bearing, the stretching of the ligament may be the primary factor. Concerning the elongation of the internal condyle and uprising of the inner tuberosity of the tibia, it would appear probable that there is an active increase of growth at the inner part of the epiphysial line, and a deficient growth or premature synostosis of the epiphysis and diaphysis at the outer part, both being probably induced by the diminished pressure on the inner, and increased pressure on the outer condyle, due, in the cases of rickets, to the mere weight of the body of the child in walking, and in older patients to carrying heavy weights, etc.

Symptoms.—The deformity is usually quite evident, although in slight cases it may be somewhat disguised by the patient flexing his knees in walking. Pain or a sense of weakness is complained of after exercise; or the patient may be unable to walk, or the knees may cross each other in doing so, the malleoli in extreme cases being as much as a foot or more apart. On extending the legs with the patellæ to the front, the tibiæ are found to diverge, but on flexing the legs at right angles to the thighs the malleoli can be made to touch. This has been

explained on the supposition that, whilst the internal condyle is longer than the external below, they are on the same level posteriorly; but the more probable explanation would appear to lie in the fact that the plane of the joint is obliquely placed.

Treatment.—In slight cases where the bones are still soft the deformity may be cured by keeping the child entirely off its legs by means of suitable splints, combined with the use of the dietetic, hygienic, and medicinal treatment indicated in rickets. Slight cases also in older subjects, when appearing to depend on the relaxed state of the internal lateral ligament, may also be cured by the long use of instruments. For such, an outside leg-iron stretching from a pelvic girdle above and attached to a boot below, and provided with a knee cap, a free joint at the hip and ankle, and a double joint at the knee permitting of flexion and extension, and of lateral movements to correct the deformity, should be worn during the day. At night the legs should be bandaged together with a pad between the knees, or a night instrument worn consisting of a trough for the thigh and leg with a ratchet joint at the knee. It is only in very slight cases, however, that instruments are of any service. By their use the legs can, no doubt, be straightened, but it is at the expense of stretching the external lateral ligament, and consequently rendering the knee joint so flail-like that the patient is unable to walk, and hardly to stand, without his irons. A striking example of this was furnished lately by a case under my colleague, Mr. Willett. The lad wore an instrument for upwards of four years. At the end of that time, when the irons were taken off, his legs could either be placed in the knock-kneed or straight position; in the latter there was a full inch between the external condyle and the tibia. He was therefore placed in plaster of Paris in the original deformed

position for twelve months till the external ligament had again consolidated. Macewen's operation was then performed, and in a few weeks the lad could walk without instruments, with strong and useful knee joints. The best and quickest treatment, except in slight cases, would appear to be some form of subcutaneous osteotomy of the femur, although in France forcible straightening, either by the hands (*Delore's method*) or by an instrument called an osteoclast, is the operative procedure which has perhaps met with most favour. The scope of this work does not permit of a description of the various forms of osteotomy that have of late years been invented. A short account, however, of those known as Macewen's, Ogston's, and Reeves's (the operations now commonly practised) will be given.

Macewen's operation consists in partially dividing the femur just above the epiphysis with a chisel, leaving the posterior part of the bone which is in contact with the popliteal artery intact, and then cracking this across by forcibly straightening the limb. It is the operation now most frequently done, and although it has in a few instances been attended with serious accidents, such as a wound of the popliteal artery, it has been performed many hundreds of times with the best results.

Ogston's operation consists in sawing obliquely, while the limb is in the extended position, through the internal condyle, which, thus separated, slides upwards on to the diaphysis when the leg is forced into a straight position. The chief objection to it is that the knee joint is opened, and that it is liable, in consequence, to be followed by inflammation and stiffness of the joint, and even by suppuration and anchylosis.

Reeves's condylar operation is a modification of Ogston's. The condyle is loosened with a chisel

instead of a saw. The object aimed at is to introduce the chisel behind the synovial membrane, and to stop short of the articular surface so as to avoid opening the joint. Though it is questionable whether the joint is not as often opened as not by this method, the chisel appears to do less damage than the saw, and the operation has been followed by few, if any, of those complications that have attended Ogston's.

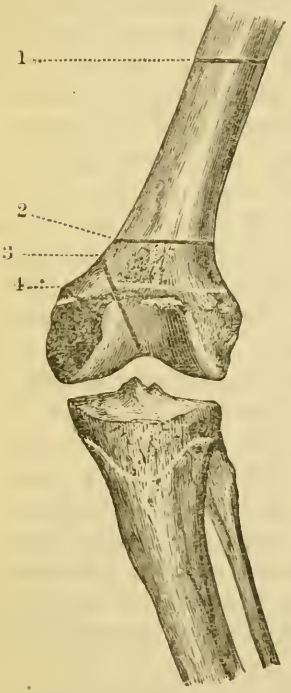

Fig. 81.—1, Reeves's diaphysial operation; 2, Macewen's operation; 3, Ogston's operation; 4, Reeves's condylar operation.

In *Reeves's diaphysial operation* the shaft of the femur is partially divided with the chisel from the outer side at the junction of the middle with the lower third, and then cracked across. (The line of these various osteotomies is shown in Fig. 81).

Delore's operation consists in forcibly straightening the limb. The object aimed at is the tearing of the lower epiphysis of the femur from the diaphysis, but it is doubtful whether other injuries, such as rupture of the external lateral ligaments, etc., are not as often produced, as it has been followed by suppuration, necrosis of the femur, and other complications. MM. Robin and Collin have invented instruments for making Delore's operation more precise, which then goes by the name of **osteoclasy.** After any of these operations the limb should be

placed in a straight position on a long splint or in Bavarian plaster splints for a month, and subsequently for another six weeks in ordinary plaster bandages, till consolidation has occurred.

Bow-Legs.

Genu varum, or bow-legs, is a deformity in which, when the malleoli are placed in contact with the knees fully extended and the patellæ looking directly forwards, the knees, instead of being in contact, are separated from each other by a variable interval. As in knock-knee, both legs, or one leg only, may be affected, or there may be genu varum on one side and valgum on the other. It is frequently associated with a bowing outwards of the shaft of the tibiæ, just below the upper epiphysis, or at their lower thirds, and sometimes with a bowing of the femora as well. The symptoms are self-evident, and what has been said of the cause, pathology, and treatment of genu valgum will nearly apply to genu varum, if *external* be substituted for *internal* in the phraseology. Where the tibia and fibula are much curved, and the bones have become consolidated in the deformed position, either subcutaneous linear osteotomy or the removal of a wedge-shaped piece from the tibia, with fracture of the fibula, may also be required.

Deformities of Great Toe.

Hallux valgus and hallux varus are terms applied to a deformed and partially dislocated great toe. In *hallux valgus*, the great toe at the metatarso-phalangeal joint is abducted and partially dislocated from the metatarsal bone, and crosses in extreme cases either over or under the second and even the next toe. The deformity is generally attributed to wearing too short or narrow-toed boots, but long-standing gout and rheumatism are thought by some to have some share

in its production. The little toe is often dislocated inwards at the same time, whilst the other toes are drawn up claw-like to make room for the great and little toes below them. In long-standing cases the external lateral ligament becomes shortened, and the head of the metatarsal bone distorted and thickened by absorption and the deposition of new bone around; whilst in consequence of the continued chafing and pressure of the boot, the skin over it becomes callous, and a bursa is generally produced. This bursa is very apt to become inflamed, and is then known as a *bunion;* or it may suppurate and produce an intractable ulcer; or should it communicate with the joint, this also may be attacked, leading to caries and necrosis of the bones, or to ankylosis. In old people such an ulcer may become a starting point of senile gangrene.

Treatment.—Slight cases are readily remedied by wearing properly shaped boots and by avoiding too long standing and over-walking. The boot should have low heels, and square toes, be straight along the inner edge and sufficiently long and wide to allow plenty of room for the toes to resume their normal position. In severer cases some form of apparatus for drawing the toe into its normal position must be employed. Thus a chamois leather cap may be worn over the toe, from which a piece of elastic webbing passes along the inner side of the foot, and is fixed round the heel by bands of adhesive plaster; or a steel sole plate having partitions of a soft material for separating the toes may be worn in the boot, or a wedge may be fitted to such a plate to keep the great toe from its neighbour. At night a light shoe, provided with a bunion spring, may be worn. "This spring has an oval opening over the bunion to avoid direct pressure on the affected joint, and the toe is gradually everted by a small strap passing round it, fixed to the end of the spring."

The bursa should be protected by soap plaister, and when enlarged and painful painted with tincture of iodine, or rubbed with biniodide of mercury ointment. Should it suppurate a free incision should be made and a poultice applied. The ulcer met with in this situation usually requires a stimulating treatment; but when the opening is small and the skin undermined, it should be laid freely open and the redundant skin cut away. In some cases amputation of the toe may be necessary.

Hallux varus is very much less common than valgus. In it the great toe is partially displaced inwards and carried away from the other toes, instead of towards them as in valgus. It may occur in talipes equino-varus, in knock-knee, in some paralytic affections, from contraction of the abductor pollicis, etc. Should it continue after removal of the cause, a properly shaped boot must be worn to keep the toe in place, but tenotomy of the abductor pollicis may be required.

Hammer toes.—This term is applied to a condition of the toes in which the first phalanx is extended and the second and ungual flexed, so that the toes present a claw-like appearance. It is generally present, as has been stated, in talipes equinus and cavus, and in hallux valgus, but may be met with as an independent affection from wearing too short boots. It is then generally limited to the second or third toe, over the dorsal surface of which corns commonly form. Tenotomy of the extensor tendons, and even amputation of the first phalanx, may be necessary. (*See* also Talipes cavus.)

Supernumerary digits are frequently associated with other deformities as webbed fingers or toes, double hands or feet, club foot, etc. They appear to be hereditary, and often occur in several members of the same family. There may be simply an increase

in the number of fingers or toes, the extra digits being either of normal size, or, as is more frequent, shorter and smaller. But the most common abnormality is a shrunken and malformed little finger or thumb, attached excrescence-like by a pedicle, often consisting merely of skin, though sometimes containing a slip of tendon. An extra toe often causes no inconvenience, and need not be interfered with, but a supernumerary finger should, as a rule, be amputated at an early period. As it may articulate with the metacarpal bone by a joint common to it and the normal finger, it is better to saw through the phalanx close to the articular surface rather than to disarticulate.

Congenital hypertrophy.—This rare condition is generally limited to one or more digits, but it may affect the whole of one or more limbs. It may involve all the tissues of the affected part, or be limited to the bone or to the skin and subcutaneous tissue. Sometimes it takes the form of a distinct excrescence consisting of subcutaneous tissue and fat. The removal of the affected part, where this is practicable, is generally indicated.

Deficiency of bones. — Almost every bone in the body has been found in part or wholly deficient. Among the most common of such deficiencies may be mentioned absence of the radius with part of the carpus and one or more fingers in the upper extremity, and of the tibia, with deficiency of some of the tarsal bones, and bones of the toes in the lower. Little can be done in the form of surgical treatment, but in the case of the lower extremity some form of leg iron may be found that will aid the patient in walking.

VII. DISEASES OF THE HEAD.

Frederick Treves

Erysipelas of the scalp is common, and the bulk of the examples of the idiopathic form of the disease are in this situation. The inflammation spreads with unusual rapidity, but owing to the tenseness of the scalp, redness is but very little marked, and swelling is inconsiderable. Certain cerebral symptoms are common (headache, vertigo, drowsiness or restlessness, delirium), and depend usually upon hyperæmia of the pia mater. Owing to the possibility of cerebral complications the prognosis in erysipelas of the scalp is a little more grave than that of erysipelas elsewhere. The form of the disease most often met with is that known as the "cutaneous."

Cellulitis, or **diffuse phlegmon of the scalp,** refers to a spreading inflammation, commonly erysipelatous, that involves the loose layer of connective tissue between the aponeurosis of the occipito-frontalis and the pericranium. It is usually due to a wound opening up that layer of tissue, but may depend also upon deep ulceration, or upon suppuration following fracture, etc.

There is a deep rapidly spreading swelling. The parts are hot, tender, painful, and brawny. Fluctuation appears at certain points. The constitutional symptoms of suppurative fever are marked. In time the whole scalp may be lifted up, and may be found resting upon a stratum of pus.

If the matter escapes spontaneously it usually finds a vent in the temporal or mastoid regions. Sloughs of the connective tissue are discharged; necrosis may follow. The inflammation may extend to the meninges,

or thrombosis of the cerebral sinuses may follow. The case may end in fatal pyæmia. In favourable cases prolonged suppuration usually supervenes.

Treatment.—The head should be shaved and free incisions made as soon as suppuration is suspected. These incisions should be made at the most dependent spots possible, as near to the attachments of the aponeurosis as the swelling extends, and out of the way of the scalp arteries. The whole scalp should be poulticed with wood wool poultices, and all the incisions be freely drained. The ordinary constitutional treatment must be carried out.

When the more acute symptoms have subsided, the head may be compressed by means of a Martin's elastic bandage, so as to prevent spreading or bagging of the pus. All sloughs should be removed as soon as they are free; and the drainage tubes retained until the discharge has become insignificant.

Abscess of the scalp may be met with in three situations: 1. In the scalp proper, above the aponeurosis. 2. In the lax tissue beneath the aponeurosis. 3. Beneath the pericranium. Abscesses in the first and third situations are circumscribed, but those beneath the aponeurosis are generally diffuse. Scalp abscesses may follow contusions, ecchymoses, wounds, fractures, the breaking down of scrofulous or syphilitic deposits, and bone affections. They all demand an early incision, but, apart from this, call for no special treatment.

Tumours of the Scalp.

Hæmatoma.—Collections of blood (like abscesses) may be met with in three situations: 1. In the substance of the scalp (these are small and circumscribed). 2. In the lax tissue beneath the aponeurosis (these hæmatomata may be very extensive, and may involve nearly the whole of the

vault, being limited only by the attachments of the aponeurosis). 3. Beneath the pericranium. The first two named follow simple contusions, and demand no special consideration. The last named are usually spoken of as *cephal-hæmatomata*, and present some points of interest. They are met with in the newly born, depend upon some injury received during birth, are more common in males than in females, and are usually situated on the parietal bone, especially that of the right side. They usually appear within forty-eight hours of birth, and form soft, elastic, fluctuating, and painless tumours of variable size. They are always precisely limited by the pericranium, and therefore never extend beyond a suture. In a few days the centre of the swelling feels soft, and around its margin is noticed a tolerably hard ring. The latter is probably due to partial coagulation, and in old cases may be replaced by a harder ring of ill-formed bone. The prognosis is favourable, the swelling disappearing in from fifteen days to two months. The condition calls for no treatment.

Sebaceous cysts are peculiarly common on the scalp. They are apt to be multiple and may attain great size. They form roundish tumours with very distinct walls. They are movable, possessed of faint fluctuation, and cannot be separated from the skin. When of large size the hair that covers them atrophies, and the tumour becomes bare. They are of very slow growth, may remain stationary for an indefinite time, are painless, and contain altered sebaceous matter and epidermal *débris*. Many present a black point upon their summits. They are apt to suppurate if injured.

When suppuration occurs the skin in time gives way, the sebaceous matter protrudes, and granulations spring up from the exposed sac wall. In this way a fungating vascular mass (*the follicular or fungating*

ulcer of the scalp) may be produced, which closely resembles epithelioma. From this disease, however, it may be separated by the history of the case, by the previous existence of a sebaceous cyst, by the absence of any infiltration at the margins of the sore, and of any enlargement of lymphatic glands. The only mode of treating sebaceous cysts is by excision.

Congenital dermoid cysts resemble the sebaceous cyst in most points. They are, however, small, seldom exceeding a diameter of two-thirds of an inch, are of very slow growth, are congenital, and contain in addition to sebaceous matter, as a rule, a number of fine hairs. They are most common at the outer angle of the orbit, and always have deep connections with the pericranium. They may lie in actual depressions in the cranial bones. They should be excised when possible, but those about the orbit have often such deep connections as to render complete excision impossible or inadvisable.

Horns.—These strange excrescences are developed from the interior of a sebaceous cyst that has been opened up by rupture or inflammation. They are formed of sebaceous matter that has become dry and horny from exposure. As fresh matter is constantly being produced by the cyst wall at its base the horn grows. Some have attained the length of six or eight inches. They can be best treated by carefully excising their bases, including the whole of the remains of the sebaceous cyst.

Pachydermatocele.—This remarkable affection is also known as elephantiasis, and as hypertrophy of the scalp. It consists of an immense over-growth of the scalp tissues. The tumour formed consists mainly of connective tissue, and hangs down as a huge pendulous tumour, that is often lobulated, is flabby to the touch, is painless, and covered by normal skin (Fig. 82). The tumour may cover the eyes and even drag upon

the mouth. It is innocent, and causes distress only by its bulk. In some cases it is congenital, in others it appears at puberty or in young adults. It is most common about the temporal or parietal regions. Some benefit may attend the use of long continued pressure, but if this fails excision offers the only alternative treatment.

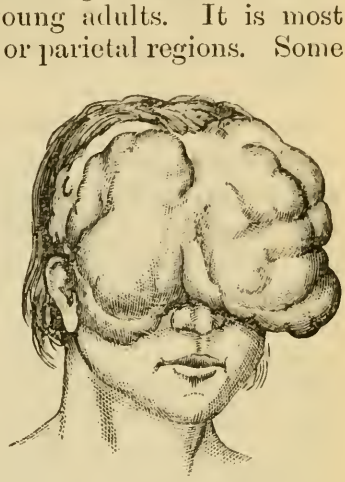

Fig. 82.—Pachydermatocele.

Pneumatocele. — This name is given to a tumour containing air; the collection is beneath the pericranium. Pneumatocele is usually met with over the mastoid process; one case has been described as existing over the frontal sinus. The mastoid cells or frontal sinus have become perforated, and air finds its way under the pericranium from the middle ear in the one case, and from the nose in the other. The perforation may be due to accident, to caries sicca, or to atrophy of the bony walls of the cells or sinus. The tumour is small, round, painless, and tympanitic. By pressure it may be made to disappear. Its progress is exceedingly slow, and it usually produces no trouble. It should be treated simply by the pressure of a carefully applied pad.

In addition to these special tumours, the following are also to be met with in the scalp: Nævi; cirsoid, racemose, and arterio-venous aneurisms; arterial varix; sarcomata; fatty, fibrous, and papillomatous growths. The three last named are very rare. These tumours, differing in no essential respect from like growths found elsewhere, demand no especial notice. Nævi and arterial angeiomata are more common on the

head than in any other part of the body. The first named are most often met with about the anterior fontanelle, the orbit, and the temple, and the latter in connection with the temporal, posterior auricular, and occipital arteries.

AFFECTIONS OF THE SKULL.

Meningocele; encephalocele, hydrencephalocele.—These terms are applied to certain tumours that consist essentially of a protrusion of some part of the cranial contents through an aperture in the skull. They are all congenital. When the tumour contains a protrusion of the meninges only, the term meningocele is used; when a protrusion of brain, the term encephalocele; and when the mass is formed by a portion of brain, greatly distended with fluid from a dropsical ventricle, it receives the name of hydrencephalocele.

Of these three tumours the last named is the most common, while the pure meningocele is the most rare.

These protrusions depend upon congenital defects in the development of the skull, whereby gaps are left in the cranial bones.

Situation.—The most common site is the occipital region, where the gap is found about the middle line of the occipital bone, and whence it may extend to the foramen magnum or the posterior fontanelle.

The site next in frequency is the root of the nose, the protrusion leaving the skull between the cribriform plate and the frontal bone, and appearing externally between the frontal and nasal bones. Tumours in this site are usually much smaller than those on the occiput, and being very often covered by red and vascular skin, have been mistaken for nævi. The rarest situation is at some point (usually at a suture line) about the sides or base of the skull. Tumours developed in the latter situation have projected into the orbit, the mouth, and the pharynx.

Symptoms.—These protrusions appear as roundish elastic tumours, covered usually by normal skin, which may, however, be greatly thinned and also excoriated. They usually have a pulsation synchronous with the heart, and may be reduced more or less by pressure, such reduction being often followed by brain symptoms (headache, vomiting, convulsions, stupor, etc.).

They are often pedunculated and pendulous. The hole in the skull can usually be made out. On forcible expiration the tumour as a rule becomes more tense or increases in size. If the mass be small the skull will be normal in outline; if large, the child will be microcephalic.

The separate symptoms and the features in the differential diagnosis are exhibited in the following table.

	Size and Surface.	Pedicle.	Fluctuation.
Meningocele	Small. Surface smooth.	As a rule pedunculated.	Most distinct.
Encephalocele	Small. Surface smooth.	Wide base. Rarely pedunculated.	Absent.
Hydrencephalocele.	Often large and pendulous. Surface often irregular or lobed.	As a rule pedunculated.	Distinct.

	Translucency.	Pulsation.	Reducibility.
Meningocele	Perfect.	Rarely present.	Always reducible.
Encephalocele	Opaque.	Distinct.	Reducible, but not completely.
Hydrencephalocele.	Translucent only at most dependent or most prominent parts.	Rarely present.	Irreducible.

Prognosis.—The majority of the subjects of these deformities die within a short period of birth. In hydrencephalocele the prognosis is absolutely bad; in meningocele it is the least hopeless. In most cases the tumour increases, and in time bursts, causing death from collapse, convulsions, or acute meningitis. It may, however, remain stationary, and the patient may attain adult life. In the case of meningocele, the bony gap may become so narrow that the cavity of the tumour is cut off from the cranial cavity, and a spontaneous cure follows.

Fig. 83.—Hydrencephalocele.

Treatment. — The mass should be simply protected. Operative interference is only justifiable under *one* condition, viz. when rupture of the tumour is threatening. 1. Meningocele. Empty the sac with a capillary trocar, and repeat the tappings as the sac refills. This has resulted in cure. If, however, the sac re-fill in a shorter time after each tapping, and the fluid become dull, injections of iodine may be used (tr. iodi. one part, water two parts); this measure has, however, met with little success. As an alternative the excision of the sac under antiseptic precautions may be entertained. 2. Encephalocele. Repeated tappings (if there be fluid in the sac), followed by pressure by means of an elastic bandage, may be employed. 3. Hydrencephalocele is not adapted for any operative interference.

Caries and necrosis.—Caries of the skull is less common than necrosis, and may be due to injury, to syphilis, or to scrofula. It is most often met with on

the external table, but may commence in the inner table or the diplöe. The bones usually involved are, in order of frequency, the frontal, the mastoid, and the occipital. The disease may be very extensive, and in any form the cranial vault may be perforated. This perforation may occur at many spots, especially in the syphilitic form, and through the holes so formed the pulsations of the brain may be recognised. In such cases the dura mater is thickened by inflammatory deposit.

The pathology and general symptoms of the affection do not differ from those of caries elsewhere. The gravity of the disease depends to a great extent upon certain *special complications*. These are pyæmia from suppurative phlebitis of the diploic veins, thrombosis of the cerebral sinuses, collections of pus between the dura mater and the bone, meningitis of the convexity, and, in rare cases, abscess of the brain.

Treatment.—Treat the constitutional condition. Evacuate all collections of pus; keep the parts clean. If the caries be spreading, a cautious use of the gouge may be advised. If pus be pent up either in the substance of the bone or beneath the dura mater, the application of the trephine is called for. In many cases, also, of early spreading caries, the trephine, not necessarily applied through the whole thickness of the skull, may arrest the disease.

Necrosis may follow contusions, lacerations of the scalp, fractures, burns, and extravasations of blood beneath the pericranium or the dura mater, or it may follow the eruptive fevers, or depend upon scrofula or tertiary syphilis. The last named cause is the most common of all.

In the idiopathic forms the frontal and parietal bones are most often involved. The whole thickness of the bone may necrose, but more usually the disease

involves only the outer table. In very rare cases it has involved only the inner table.

The necrosis is usually limited, but it may be very extensive, and in some recorded cases nearly the whole of the vault of the skull has been lost by necrosis in the process of years.

The mode of separation of the sequestrum is the same as that observed in necrosis elsewhere (*see* Art. II., page 124), and the only pathological feature special to skull necrosis is the absence of any new bone formation. The sequestrum is not retained or invaginated by new bone, and the gaps left in the cranium after the separation of the sequestra are filled up by fibrous tissue only. The special complications that may attend caries may attend necrosis.

Treatment.—Give free exit to all discharges. Superficial necrosis may be practically left to itself, or the process of exfoliation may be aided by the use of strong sulphuric acid. Remove all loose sequestra. If the dead piece be too large for convenient removal, it may be trephined and removed in segments. The trephine may also be used when pus collects between the dura mater and the bone.

Tumours of the skull. Osteomata.—Those bony tumours that grow from the outer table of the skull are called exostoses, those springing from the diplöe or inner table enostoses. Some are spongy or cancellous in structure, but the majority have the structure of ivory exostoses. These tumours are often multiple, sometimes symmetrical, and are most commonly found in connection with the frontal bone, and next in frequency with the mastoid and occipital bones. They are usually irregular and bossy; they are of slow growth, and only cause trouble when they compress the brain (enostoses) or grow into the orbit or nose. Exostoses in the latter sites may necrose *en masse*. In the great majority of cases these tumours

call for no operative interference, and are indeed affected by none.

In very rare instances the following *growths* have been met with in the skull. Hydatid cysts; angeiomata; sarcomata growing from the pericranium or the diplöe. These tumours are usually of the spindle-celled variety, and are more often secondary than primary. If growing from the diplöe they expand the outer table, and for a time form tumours with thin bony shells. They are beyond treatment.

Carcinoma of the skull is met with, but always as a secondary affection.

Fungus of the dura mater.—This term is applied to a sarcomatous tumour growing from the dura mater (and in very rare instances from the pia mater or arachnoid) that has penetrated the cranium, and has appeared under the scalp.

The growths may be primary or secondary. The former are the less common and are single, the latter are due to metastasis and are often multiple. This form of sarcoma is rare, since the majority of the sarcomata of the dura mater do not perforate.

Symptoms.—In most cases no symptoms precede the appearance of the external tumour. In other cases there are cerebral symptoms (headache, neuralgia, vertigo, vomiting, convulsions, etc.). As the tumour makes its way through the bone, a soft spot of thinned bone may perhaps be felt at the vertex, which crackles on pressure. This thin bone gives way, and the sarcoma protrudes as a small flat firm tumour that pulsates and can be reduced on pressure; on reduction the hole in the skull may be made out. The mass soon grows, and, spreading beyond the hole, becomes more prominent and softer, and at the same time irreducible and no longer pulsating. If the patient lives long enough the mass may fungate through the

scalp tissues. Sarcomata growing from the bone are harder, are never reducible, and never pulsate.

The affection is rapidly fatal, and is beyond the reach of any but palliative treatment.

Hypertrophy of the skull.—1. Some few cases of *simple hypertrophy* have been noted. The subjects have usually been advanced in life. The hypertrophy has involved the entire skull evenly, or has been limited to some portion of it. The cause of the condition is unknown.

2. *Osteo-porosis.*—This term is applied to certain large thick skulls with obliterated sutures, the bones of which on section appear uniform and finely porous like white brick. The general shape of the skull is, as a rule, not altered, but the component bones may be four or five times their normal thickness. This change is more or less entirely limited to the vault of the skull. In some cases this peculiar hypertrophy has been associated with osteo-malacia, and in other instances with osteitis deformans. In the latter affection, however, the bones are usually quite dense on section, and the dimensions of the skull are greatly increased in all its diameters. (*See* Art. II., page 129.)

3. In *leontiasis ossium* the skull is thickened and deformed by the growth of irregular bossy masses of rough and porous bone. These masses may be very large, are often symmetrical, and produce great deformity. The frontal, parietal, and malar bones are most often affected, the orbits and nasal fossæ may be encroached upon, and certain of the cranial foramina closed. It appears usually at or before puberty, and is of unknown origin. Pressure symptoms of various kinds may arise.

No form of hypertrophy of the skull is amenable to any but palliative treatment.

Chronic hydrocephalus.—This term is applied to a disease of young children characterised

by certain accumulations of fluid within the cranial cavity. The fluid may be within the ventricles (internal hydrocephalus), or in the subdural space (external hydrocephalus).

Internal hydrocephalus is the usual form. The ventricles are enormously distended, the ganglia flattened out, the convolutions unfolded, and the brain matter very greatly thinned. In severe cases the

Fig. 84.—Chronic Hydrocephalus.

covering of brain matter may not be more than half to a quarter of an inch thick over the most distended parts of the ventricle. The head enlarges, the bones are separated, and the fontanelles and sutures become of considerable width. The orbital plate of the frontal is thrust down, and the cavity of the orbit becomes greatly narrowed. The zygomatic fossæ are filled up, the scalp is full and tense, and covered by prominent veins. Fluctuation may be detected in the gaps between the bones.

External hydrocephalus cannot be detected from the internal form except in this, that there is in the present

variety no displacement downwards of the orbital plate of the frontal bone.

The *prognosis* is bad. The great majority die of exhaustion, or of coma, or convulsions, or even acute cerebral mischief. The cases where the child has grown up to adult life or even survived a few years are quite rare.

Treatment.—With the general treatment of the disease the present article has no concern. The local treatment proposed in certain cases consists (1) in the use of pressure, and (2) in paracentesis.

1. Pressure may be applied by means of strapping or an elastic bandage. It is merely a palliative measure that may do good in some cases, while in others it excites cerebral symptoms, and cannot be borne.

2. Paracentesis has met with so little success that the operation is now seldom practised. It has afforded temporary relief in a few instances, and has appeared to check the disease when progressing rapidly. A very fine trocar is entered at the coronal suture, about one inch from the anterior fontanelle, and is pushed downwards and backwards; only a small quantity of fluid is drawn off at a time.

The use of iodine injections in hydrocephalus has been only attended by unsatisfactory results.

Removal of cerebral tumours.—This procedure has been, so far, adopted in one case only. The surgeon was Mr. Godlee; the physician in charge of the case, Dr. Hughes Bennet.* The patient was a man, aged 25. His chief symptoms were agonising headache, vomiting, optic neuritis, and paralysis of the left upper limb.

There were no external evidences of tumour. Dr. Bennet diagnosed a tumour of the cortex, at the middle third of the fissure of Rolando, and at this

* Med.-Chir. Trans., 1882.

spot a glioma the size of a walnut was discovered at the operation. The opening in the skull was made by three trephine holes, each with a diameter of one inch. The growth was removed by means of Volkman's scoop. Bleeding was arrested by the cautery. The procedure was conducted under Listerian precautions. The operation did not affect the patient's intelligence, and led to no special disturbance. His symptoms were for a while much improved. Unfortunately the wound became septic, a hernia cerebri formed, and the patient died at the end of four weeks of meningitis. But for this surgical accident there is every reason to suppose that the case would have resulted in complete cure.

VIII. INJURIES OF THE HEAD.

Anthony H. Corley.

Injuries of the Scalp.

Injuries of the scalp, though always of importance, yet frequently become of secondary interest, in consequence of being accompanied by some lesion of the skull or its contents. Whilst subject to the same classification as injuries of other regions, the peculiar anatomical structure in which they occur often gives scalp wounds a character of their own. Notwithstanding the frequency and triviality of "cut heads," there is generally a disposition to over-rate their gravity, first, because of their possible complication with deeper injuries; and secondly, because of an old and deeply-rooted belief that they are more likely to be followed by erysipelas and allied diseases than are wounds of other regions.

They may be divided thus: A. Contusions. B. Wounds. The latter may be subdivided into (1) incised, (2) contused, (3) lacerated, (4) punctured, (5) poisoned, (6) gun-shot, and (7) "flap" wounds, these last being usually a combination of contused and lacerated injuries, worthy of particular mention.

Before entering upon a description of these lesions, it may be well to glance at the *anatomical arrangements* which confer special characters on some of these injuries.

The scalp is a complex structure tightly covering, but movable upon, the cranium. Its principal components are: the skin with its appendages, and the occipito-frontalis muscle with its intervening tendon, the epicranial aponeurosis. Of great importance, from

a surgical point of view, are two planes of connective tissue, one between the skin and subjacent aponeurosis, and the second separating the aponeurosis from the pericranium. The first or exterior layer of connective tissue is of a dense, fibrous character, containing in its substance the blood-vessels and nerves; whilst, as the muscle is to glide freely over the cranial vault, the layer beneath it is of a loose character, readily torn and sparingly supplied with blood. Removal of the scalp, for whatever purpose, is effected by tearing through this inferior layer, and is a process very readily performed. Pus formed within the superficial plane most commonly constitutes an abscess, and blood in the same position a circumscribed tumour, but when either is found in the deeper connective tissue layer it forms a diffuse swelling, tending to project in the direction of the eyelids or ears.

The fact, too, that the copious blood and nerve supply of the scalp lies in the subcutaneous connective tissue, explains the well-known axiom that practically the scalp never sloughs; for, though it is true that a portion of it may be destroyed by direct injury or pressure, yet the mortification is limited to the part immediately involved. In the case of the scalp, deep-seated suppuration is powerless to destroy the vitality of the superficial parts, whose blood-vessels the pus can neither strangle nor destroy. The lymphatic vessels of the scalp are numerous, and seem specially prone to propagate the results of irritation of their peripheral ends to the glands in the neck.

A. **Contusions of the scalp** may be divided into those special to new-born children and those found at all other periods of life.

The former are the direct result of injury during parturition. Amongst them the ordinary scalp tumour or *caput succedaneum*, found in most cases of head

presentation, can scarcely be reckoned as a morbid condition, inasmuch as it is caused by mere local congestion and œdema due to mechanical obstruction of the venous trunks by the contracted os uteri. When, however, the constriction has been more considerable or has lasted longer, some of the dilated blood-vessels may be ruptured and an extravasation take place, in which case a more serious condition results, and a tumour is formed which has received the name of cephal-hæmatoma. (*See* Article on Diseases of the Head.)

The other *contusiones neonatorum* are localised and small, and are produced by direct violence, either from maternal structures or from obstetric instruments.

These contusions vary in intensity and effects; slight ones tend to rapid resolution, but a greater degree of pressure may result in ulceration or sloughing. The natural vitality of the infantile structures usually influence even those conditions, and frequently the morbid action terminates in healing, but sometimes more severe consequences ensue, such as shock, localised spasm, or paralysis.

Contusions at other periods of life vary in extent from the slightest subcutaneous ecchymosis to the formation of a bloody tumour, and when they occur in the supra-orbital region they may present special and important local complications.

The *simple contusion* requires no special description, nor does it call for any special treatment.

The *traumatic bloody tumour of the scalp*, however, requires a special description, and it is not always possible to say, with certainty, into which plane of connective tissue the blood is extravasated. Though usually, when the tumour is large, the extravasation is under the epicranial aponeurosis; in many cases its presence is complicated by a fracture of the skull, when it may lie, possibly, under the pericranium.

The cause of the tumour is usually a severe injury, such as a blow of a heavy instrument, or a fall on the head from a height. A soft fluctuating tumour is in these cases readily felt, yielding to pressure at its centre, but giving the feeling of having a hard and sometimes apparently sharp margin, a distinction which results from the fact that the central portion contains fluid, and the circumference coagulated, blood.

The *diagnosis* between such an extravasation and a depressed fracture of the skull is easily laid down, but not always so easily made; and instances are not infrequent in which surgeons of great experience have been doubtful or even mistaken in their judgment. These doubts arise from the fact that the centre of the tumour is sometimes so soft, and the hard margin so sharply defined, that the sensation it conveys to the touch strongly suggests a fracture with depression, especially as the cause of the injury may have been of such a nature as to produce depression. But then, the surgeon is to remember that, in the case of a fracture, the finger, when palpating the margin, passes at once from the level of the surrounding surface into the depression, whereas, in the case of bloody tumour, the finger first passes up the elevated margin of the coagulated blood before it dips into the central, yielding, fluid portion; and, if pressure enough be made, the tip of the finger, displacing the blood, feels at length the resistance of the subjacent bone. In reference to this last test, it must be remembered that its use would not be justifiable if any reasonable grounds existed for thinking that the case was one of depressed fracture, as such pressure might then be highly injurious. It may be pleaded in justification of doubts, or mistakes in the diagnosis of the two conditions, that extravasation and fracture may co-exist.

As regards *treatment*, the part must be as little disturbed as possible, and absorption must be aided

by discutient lotions. The extravasation will probably be absorbed in time. No incision is necessary unless suppuration be imminent or have already occurred, when any delay in opening and evacuating the tumour is fraught with evil consequences.

Injuries implicating the supra-orbital regions, whether or not they are accompanied by signs of contusion, have been frequently followed by sudden loss of vision; and for this reason they deserve special mention. The theory formerly accepted was, that the loss of sight depended on injury of the supra-orbital nerves, producing, by a reflex process, a loss of function in the retina, and we find not infrequently in the older books the heading, "Amaurosis from supra-orbital injury." The ophthalmoscope, however, has revealed the fact that, in these cases, dislocation of the lens, retinal detachment, and retinal hæmorrhage often occur, and thus afford a more reasonable explanation of the loss of sight than was conveyed by the term reflex amaurosis.

B. **Wounds.**—*Incised.* Ordinary incised wounds of the scalp require little description other than that applicable to similar injuries occurring elsewhere, and they present no immediate danger, save that of hæmorrhage, for controlling which there are greater facilities here than in other regions. When the cut is perpendicular to the subjacent bone the surface around should be shaved, the edges brought closely together and held in apposition by strips of plaister, and, this being done, immediate union may be looked for. Should a vessel have been divided, a pad of lint, fixed by a few turns of a bandage, is usually sufficient to restrain bleeding, as the bone affords steady counter-pressure. In case the bleeding persists it may be found to depend upon the fact that an artery has been only partially divided, in which case the point of a scalpel will soon remedy the difficulty,

and allow the pressure to act more efficiently. In some wounds, especially in those necessarily inflicted in operations on the head, the bleeding point in the cut edge of the scalp can be seen. Here a special procedure is necessary, for it is difficult, and often impossible, to tie the vessel, inasmuch as it is so closely embraced by the fibres of the first connective layer, that it cannot be drawn out sufficiently to allow a ligature to encircle it. It, however, can be crossed by an acupressure needle, with or without the additional aid of a twisted suture. When the wound is in the temporal region, it is better to use the ligature or needle at once than the pad, as the temporal fascia does not bear pressure well.

If the direction of the cut be oblique, and if the edge of the weapon have passed under the scalp for any distance, it is important to ascertain the condition of the whole wound, the absence or presence of foreign bodies, or organic impurities, before the edges are adjusted. If it should prove to be clean, or can be rendered clean, it should be at once closed and immediate union hoped for. When this result is unlikely to be obtained, it is better not to be too particular in bringing the edges of the scalp together, because matter is apt to form under the flap, and if the margin be too quickly united, it may be necessary, in order to allow of its escape, to separate them, or make a distinct incision.

The most usual cause of incised wounds is, of course, a sharp cutting edge, but sometimes such a wound may be inflicted with a blunt or flat instrument, especially if its surface be smooth. It is often found that wounds produced by falls on the ice, in skating, are as sharply defined and cleanly cut as if done by a razor. This point may prove to be of medico-legal importance.

Another form of incised wound which possesses

special importance from its sequences is the incision made in removing the ordinary sebaceous tumour or wen from the scalp, respecting which there is a common belief that it is especially liable to be followed by erysipelas. I believe that before the period of antiseptic surgery this opinion was well grounded, but of late the precautions adopted have rendered this operation as safe, practically, as any other of a like gravity.

Contused wounds are serious in proportion to their extent, position, and the amount of injury to the soft parts. It is hardly possible to secure their immediate union, and as the edges of the wound must be expected to become rounded off by limited sloughing, it is unnecessary to apply adhesive plaisters or other means of retention until the edges have begun to granulate. These wounds and the next variety are usually unattended by hæmorrhage.

Lacerated wounds are perhaps the most common of scalp injuries, varying in extent from a slight tear through the soft structures to the more severe forms included under the head of flap wounds. Lacerated wounds, having been washed and cleansed, must be treated as the last variety, bearing in mind that, in addition to the common inflammatory complications, tetanus is an occasional result.

Flap wounds.—In civil practice these are generally met with as machinery accidents, the passing over the head of a car wheel, or a fall from a vehicle in motion. In military practice they are produced by all kinds of violence: from shot, shell, sabre, or hoof of horse, and they vary in extent from a slight separation of the scalp to a tearing away of almost the whole. The dangers of flap wounds are those of contused and lacerated wounds in general, hæmorrhage being seldom present.

Treatment.—Cut the hair close or shave the flap

and the adjacent portion of the scalp, cleansing carefully the deep surface, removing all foreign bodies, such as gravel, earth, dust, etc. This can best be done by directing a stream of carbolised tepid water (1 in 80) on the torn part; but the cleansing process must not be carried on too long, lest the vitality of the flap be lowered, and because, in most cases, except those in which antiseptic treatment can be at once adopted, a good deal of suppuration is inevitable, and by this the foreign bodies will be carried away. No matter how small may be the bridge of scalp connecting the detached portion with the adjacent uninjured structure, an attempt should be made to save the flap, remembering the rule that the scalp has no tendency to slough. To retain it in position, sutures, plaisters, the four-tailed bandage, or the double-headed roller (the capeline) may be used; and it is well to bear in mind that, ancient prejudice notwithstanding, there is no objection to sutures in the scalp, their presence there being as unlikely to produce untoward consequences as in any other region. Judicious pressure by pad and bandage over the flap tends to avert the danger of deep-seated suppuration, and the too hasty union of the edges should not be sought for whilst there is any probability of this occurrence. In the event of the flap being wholly torn off or dying, notwithstanding all these precautions, a clean cut surface will be left to heal by granulation, while the pericranium, or, even when that is injured, the bone itself, will, in a short time, present a few pink granulations, which will increase rapidly and coalesce, until the whole surface is covered by healthy granulation tissue, and cicatrisation will follow. The treatment then should be of the simplest kind, water dressings and cleanliness being the chief agents; but these are not to be persevered in too long lest they produce a "soddening" effect, and a surface of the

nature of a weak ulcer, with large, pale, flabby, granulations, be the result. At this time the healing may be very much accelerated by the judicious employment of skin grafting, as there is no surface on which the grafts are more prone to "take" and their constituents to proliferate. It must be borne in mind that any method of cicatrisation eventually tends to a certain tightness and immobility, which may be productive of deformity whenever it is extensive, especially when the scar is situated in the frontal region.

Punctured wounds. — These wounds are, as a rule, looked upon with more suspicion than any others, not only from the greater likelihood of their being attended with injury of the skull or its contents, but because they are frequently followed by deep-seated inflammation. These wounds are caused by stabs of pointed instruments, blows of sharp stones, falls against projecting angles, etc., and as they are sometimes small they may be overlooked, especially if the hair be thick, and as they are usually unattended with much hæmorrhage.

Treatment.—The adjacent scalp should be shaved, and the wounds, if seen in time, dressed antiseptically, first having made a full exploration with probe or the little finger. If some hours have elapsed a linseed meal or bread and water poultice should be applied, and complications treated if they arise.

Poisoned wounds and *gun-shot wounds* of the scalp require no especial notice. (*See* Arts. XXXII. and XV., vol. i.)

Deep-seated inflammation of the scalp.— Besides the dangers of superficial erysipelatous inflammation, suppuration, pyæmia, and tetanus, which may follow upon scalp wounds as well as those in other parts, there is a peculiar form of inflammation which usually presents special features, and may be designated by this name. This inflammation is

probably erysipelatous in its character. Some two or three days after the reception of a scalp wound, which up to this period has been going on well, the surgeon observes a local change, a red blush surrounds the wound, its edges become swollen, everted, and tender, the surfaces very dry and painful, and the cervical glands probably enlarged. In the course of from six to twenty-four hours nausea supervenes, and sometimes vomiting and rigors occur, while the pulse and temperature at once mount up and the local changes become striking. In the milder cases the swelling gradually subsides without suppuration, except, perhaps, immediately adjoining the wound. In the graver cases, on the other hand, the swelling is rapid, is marked by a dusky uniform redness, and soon presents a "boggy" feel, indicating diffused suppuration, and a somewhat emphysematous crackling is felt, which denotes sloughing of the areolar tissue. The dusky swelling may increase to an extraordinary extent, the head appearing nearly double its natural size; and as the suppurating and sloughing process extend along the deep plane of areolar tissue in the direction of least resistance, the eyelids swell enormously, the eyes close, and the nose becomes monstrous. Deposits of matter in the sloughy areolar tissue form in the eyelids and near the ears, whilst the two anterior fleshy portions of the occipito-frontalis muscle, being less resistant than the epicranial aponeurosis, stand prominently forward as two semicircular tumours on the forehead, soon, however, becoming merged in the general swelling.

Constitutional signs, at first those of irritative fever, change after a short time to surgical typhoid, and thereupon the tongue becomes dry and brown, muttering delirium sets in, and general depression of the vital powers follows.

The *treatment* of this variety consists mainly in

early and free incisions, allowing matter and gangrenous areolar tissue to escape in every direction where they may present. Tonics and support will be indicated from an early period, and under this treatment even the worst cases of the disease may recover with no greater inconvenience than a tight or immovable scalp. (*See* also Art. VII., page 365.)

Contusions and Inflammation of the Skull.

The relations between periosteum and bone, so intimate throughout the entire skeleton, that injury or disease of either cannot always be differentiated, are well marked in the skull, although, from the copious vascular channels of the diplöe, the osseous structure is not so dependent on the investing membrane as in other regions.

Injuries of the pericranium may be trivial or grave, according to the amount of the original violence, and the extent of the exposure of surface to atmospheric contact. The symptoms will vary proportionately from those of slight periosteal injury, with pain, tenderness, and swelling, to extensive periostitis with its complications and sequelæ. The symptoms of serious inflammation of the pericranium resemble, as in other situations, those of erysipelas, or of deep-seated inflammation of the scalp. A blow on the head, followed, after an interval of from one to three days, by localised swelling with pain of a severe character, and accompanied or preceded by nausea or vomiting, chills, increase of temperature, and other febrile phenomena, may indicate either of these two morbid conditions. If, however, the physical signs remain localised over a particular part of the skull, and are persistent beyond the ordinary duration of scalp inflammations, if the pain also become more intense, unaccompanied, of course, by intracranial symptoms, periostitis may be suspected.

Cranial periostitis, like the same condition elsewhere, may end in (*a*) resolution ; (*b*) chronic periostitis ; (*c*) suppuration ; (*d*) disease of the subjacent bone. In the first case the symptoms gradually subside, and the localised swelling slowly disappears, while in the second case chronic thickening of the periosteum (a node) is likely to be the result. The treatment for both should be on the general principles laid down in the article on Diseases of the Bones. If in the course of the disease an exacerbation with rigors should occur, accompanied by local pitting or obscure fluctuation, subpericranial matter may be diagnosed, and free incisions should be resorted to, because here, as in other regions, the contact of pus may impair the vitality of the bone. It need hardly be said that antiseptic precautions, valuable in all cases, are here of paramount importance. Complete separation of the pericranium from the bone, whether the result of the original wound or of subsequent suppuration, may probably lead to exfoliation or to complete necrosis, but this effect does not necessarily follow.

Contusion of the cranial bones, which must necessarily involve the pericranium, present the same symptoms at first as periosteal inflammation. Contusion of the skull frequently occurs as the result of blows or falls, without producing any results beyond trivial inflammatory symptoms, local and general, of a more or less transient character. There is always a danger of more serious bone trouble, especially if the injury be compound, for then it will be attended with all the usual risks of septic infection. Cranial injuries are particularly predisposed to such infection by reason of the abundant supply of large diploic veins, which remain patent in consequence of their connections.

Osteitis, the result of injuries of the skull, presents the usual localised inflammatory symptoms,

varied according to their nature and extent. In the less serious forms the results are thickening and induration; while in the graver varieties death of the bone, osteo-phlebitis, with its consequences, septicæmia and pyæmia, extension of the disease to the dura mater, or a combination of all these conditions may follow. Should a wound be present, the occurrence of subpericranial suppuration can be diagnosed, and exit to the matter should be at once given, and if, on examination, the bone be found to be bare and dead, a subsequent exfoliation may be expected. The occurrence of repeated rigors points to *osteo-phlebitis* and *pyæmia* (Hutchinson), each rigor indicating, probably, a new focus of purulent infection in some distant organ. The occurrence of pneumonic symptoms, jaundice, multiple peripheral abscesses, or arthritic suppuration, indicate successively the locality of these foci before post-mortem examination demonstrates them. If these general evidences of pyæmic infection be present, it is not likely that operative interference with the bone will be of much benefit; but if the symptoms point rather to the implication of the immediately subjacent dura mater, with signs of localised cerebral irritation or compression, the use of the trephine is justifiable.

A sign which is generally acknowledged to be very rare, and which is known as *Pott's puffy tumour*, may be observed to follow upon injuries of the head. It appears as a tender, circumscribed, flattened swelling, and it indicates the formation of matter between the bone and dura mater, for which condition incision or trephining may be immediately necessary.

Differential diagnosis of cranial inflammation. — What symptoms, then, differentiate (*a*) simple cranial necrosis, (*b*) osteo-phlebitis, and (*c*) the extension of the inflammation to the intracranial structures? The first, simple necrosis, is

indicated by local tenderness, local suppuration, denudation of the bone, with comparatively trivial constitutional symptoms, slow in progress, followed by necrosis, exfoliation, or recovering of the bone by a process of granulation. If, in addition, recurrent rigors occur, with high temperature, sweatings, quick and feeble pulse, chest or abdominal symptoms, or swollen joints, the second condition, osteo-phlebitis, may be diagnosed. If the fever has increased, with headache, delirium, torpor, and more or less paralysis, the third condition, extension to the intracranial structures, has occurred, and may be followed by convulsions, coma, and death. The colour of the bone, when dead, is a peculiar greenish white, and it must be remembered that injuries causing the necrosis, even osteo-phlebitis and its consequences, may vary from a simple exposure of lacerated pericranium to the contusion just described, or to any of the varieties of fracture.

Fractures of the Skull.

A short classification of the fractures of the skull is necessary to a proper understanding of the complications respectively attending them.

Classification.—Fractures may be divided into : 1. Partial, implicating one or other table of the skull. 2. Complete, involving the entire thickness of the skull case. The first may be subdivided into (1) fracture of the outer table alone, such as occurs over the frontal sinuses or mastoid cells; (2) fracture laying open the diplöe ("scratch" fracture of Hutchinson) ; (3) fracture of the inner table alone.

The second class comprises (1) fissure ; (2) comminuted, stellate, or radiate fracture ; (3) punctured fracture ; (4) fracture of the base ; (5) compound ; and (6) depressed fracture. In addition to the above, a disputed lesion, the existence of which is doubted, but

which has been described as (7) fracture by *contre coup*, should be mentioned. The word compound, as applied to fractures, has the same meaning here as in other regions.

General characters.—It is well worth remarking, as Nancrede has done, "that a fracture of the skull has no inherent danger over and above similar injuries of other bones, indeed, not nearly as much, if we accept the peculiar arrangement of its diploic venous channels which predispose to purulent infection. I repeat again, a fracture of the skull, *per se*, is not a dangerous injury; and I thus reiterate the statement in order to point out the error too often made of concentrating attention upon the fracture instead of upon the concomitant cerebral injuries, and because so much has been written concerning the risk of converting a simple into a compound fracture by incising the integuments, when the former presents symptoms of cerebral compression, forgetting that, though making a fracture of the thigh compound directly imperils the patient's life, the course of the injury, as far as life is concerned, differs little in compound and simple fractures of the skull, provided that intracranial inflammation can be avoided. I do not deny that intracranial complications may be aggravated by a reckless admission of air to a previously simple cranial fracture; but I deny that with modern antiseptic precautions the danger of the operation is to be compared to the risks of intracranial inflammation from the irritation of depressed fragments of bone, and that any comparison can be justly drawn between a compound fracture of a long bone and one of the skull."

Fractures, other than simple fissures of the cranial bones, usually display a much greater injury and displacement of the inner table than of the outer.

"For the explanation of this fact there are

three factors: first, its physical structure being the more brittle of the two; second, the operation of a law which determines a fracture first on the side of greatest extension, or, as iron-masters express it, on the 'side of pull;' and third, the mass of material carried before the fracturing force. The law which determines a fracture of the skull is the same by whatever kind of force it is produced. The fibres of the bone yield first, as has been stated, on the side of extension, just as when a stick is bent over the knee the surface opposite to the point where the pressure is applied first gives way. The application of the law has been well illustrated by Teevan."

Partial fracture, implicating the frontal sinuses, may be accompanied by emphysema of the scalp, and with epistaxis, or, if it be compound, its existence may be shown by the patient being able to force the air from his nose through the wound.

Scratch fracture corresponds very closely to the contusion already described, and in certain cases we occasionally find the external table scratched by direct attrition upon some hard substance. Now and then these scratches are so superficial that, being exactly limited in length to the part actually touched by the substance causing the injury, they scarcely deserve the name of fracture. Their existence, however, always proves severe contusion of the bone, and sometimes it is very difficult to distinguish between a scratch and a linear fracture especially. They sometimes involve more than a scratch, the outer surface of the bone being ploughed up over a considerable extent, still without any fissuring (Hutchinson).

A fracture of the internal table may occur, and the external remain whole; and examples of this kind are given by Sir Astley Cooper, Velpeau, Adams, Brodie, Agnew, and others. In a patient whom Agnew trephined for traumatic epilepsy, the

inner table was found fractured and depressed without any break whatever in the outer lamina.

These cases can only be positively ascertained by such operation or by post-mortem examination.

Simple fissure, like a crack in a pane of glass, may be productive of no further symptom than that caused by shock of injury, and no doubt its existence is often undiscovered. Its presence is frequently demonstrated when the condition of the bone, or of the intracranial structures, renders incision or exploration necessary, or else on post-mortem examination.

No operative interference is indicated unless death of the bone with intracranial suppuration should produce dangerous symptoms.

Comminuted, stellate, or radiate fractures are those in which a portion of the skull case is broken into several pieces, the line of fracture sometimes diverging from a point, or a circular fragment, in which case the words stellate or radiate sufficiently indicate the characters of the injury If the stellate fracture be depressed the bone yields circumferentially, and a fissure circumscribes the radiating lines, which slope down to the place of greatest depression.

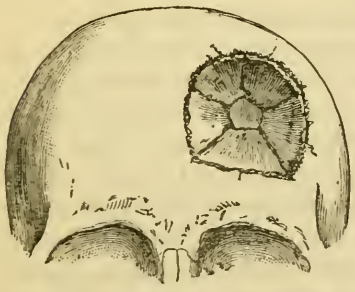

Fig. 85.—Pond Fracture of the Skull.

This has been termed by Hutchinson the "*pond*" *fracture*, the lines of which, in some cases, converge to a point as to a centre, and in others to a small circle of depressed bone like the "hub" of a wheel (Fig. 85). If it be compound, immediate elevation of the bone becomes necessary, and persistence of symptoms may force the adoption of similar treatment

when the fracture is only simple. Although in some cases the fragments are very movable, in others they are locked together so forcibly that the trephine may be required to remove a piece of the cranium outside the circumferential fissure, and it may be even necessary to detach altogether one of the depressed and locked "sectors" before the others can be raised to the normal level. "*Gutter*" *fracture* is, in principle, the same as pond fracture, but its shape is elliptical, and the greatest depression corresponds to a line in the long axis of the ellipse, towards which two surfaces of bone lead down from the fracture circumscribing the figure. If it be compound, which is more than likely, immediate surgical interference is indicated (Fig. 86).

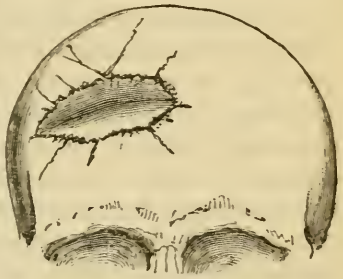

Fig. 86.—Gutter Fracture of the Skull.

Punctured fracture is one of the most serious and important to the surgeon. It is produced by a sharp point, such as a knife, dagger, scissors, reaping hook, or pitchfork, and it varies in size, complications, and dangers. Immediate cerebral symptoms may be absolutely wanting, even though the instrument that caused the injury be embedded in the brain. Fractures through the roof of the orbits or nose frequently belong to this variety, and may sometimes be deficient in any symptoms for some days, though in other cases they prove immediately fatal.

If the perforating instrument be present and be detected, it must be removed at once, and if the situation of the fracture be in the vault of the skull, the case is one for immediate trephining, as it may be inferred that the inner table of the bone is comminuted,

and that spiculæ are pressing on the meninges, or on the brain substance.

Fractures of the base of the skull may be divided into two classes: (1) Those involving only the anterior fossæ of the cranium, the roof of the orbits, or nasal cavity; originating therein, or travelling from the frontal region. (2) Those implicating the true base, or middle cranial and occipital fossæ, which fractures usually originate from below, or from the extension of a fissure from the vault.

1. Injuries of the first of these classes are produced by blows or falls on the forehead, but more frequently by perforating instruments passing through the nasal or orbital cavities; and these lesions do not necessarily imply any marked degree of violence, especially in the punctured wounds of the orbits or nose, because in their situation the bony plates are thin and fragile; consequently urgent symptoms may not be present. The treatment of such cases must be guided by the circumstances, and should be in accordance with the rules already laid down for punctured fracture.

2. In the second variety the symptoms are, as a rule, so well defined that a separate description of them is necessary. These fractures usually arise from forces acting from below, such as a fall on the feet from a height. Also from forces applied from above, such as falls or severe blows on the cranial vault, in which cases the fracture most commonly commences at the part struck, and travels downwards into the base. In the simplest cases a fissure runs through the petrous portion of the temporal bone, involving the middle ear, and sometimes rupturing the membrana tympani; but in more severe injuries the occipital bone where it abuts on the temporal is implicated, and the fissure may run backwards into the foramen magnum or transversely across the basilar process

This form of fracture frequently extends completely across the base of the skull, involving the petrous bone and the tympanum of the opposite side, and thus separating the base into halves, anterior and posterior. More commonly the line of fracture travels from the petrous bone, across the middle fossa and great wing of sphenoid to the roof of the orbit, or passing through the body of the sphenoid involves the cribriform plate of the ethmoid and roof of the nose. In still more serious cases all these lines of fracture may co-exist, the foramen magnum being extensively broken, and the summit of the vertebral column projected into the cranial cavity.

The condyles of the lower jaw may be driven by violence through the glenoid cavity, and thus produce a fracture of the base.

In an accident which presents so many varieties and degrees of local injury, the *symptoms* may be naturally expected to vary in intensity. In addition to those of concussion and compression, hereafter to be described, there are some symptoms peculiar to the accident, and indicative of the particular localities affected; thus, bleeding from the ear or ears, welling from the same cavities of a clear serum, the cerebro-spinal fluid, and deafness, point to the fissure through the petrous bone. Subconjunctival ecchymosis or chemosis of clear fluid shows the implication of the roof of the orbit. Bleeding from the nose, with an escape of serous fluid, may occur, from which it may be judged that the roof of that cavity is fissured, and a post-pharyngeal bloody tumour may result from the fracture across the basilar process. Several of the cerebral nerves may be implicated by the accident; but as there is generally profound coma present, little direct information as to their functional disturbance is available.

The *prognosis* is generally fatal, but not necessarily so. Patients presenting symptoms considered

pathognomic of the accident, have been known to recover. It may be true that such symptoms occur irrespective of the basic fracture; but, on the other hand, it has been found by subsequent post-mortem examination that in the great majority of cases they have this origin. It is, therefore, more than probable, that when patients exhibit such symptoms, and do not die, the result proves only that the slighter forms of the accident are not always fatal. This hypothesis is confirmed by the fact that there are in museums well-marked specimens of these less severe fractures, obtained at remote periods after the patients have presented these symptoms and recovered.

From the foregoing observations it will be seen that any *treatment* directed to the lesion itself is out of the question.

Fracture by contre coup. — The nature and possibility of this fracture has been a matter of much dispute. If it be held that it is a yielding of one part of the skull produced by violence, applied to the exactly opposite region, the occurrence of the precise lesion may well be questioned; but there is no doubt that in severe cranial accidents caused by considerable force, fractures do occur in other parts of the cranium than those to which the force is applied. Of such I have seen examples.

Separation of sutures.—These accidents, uncomplicated by fractures, are extremely rare. In two of Hutchinson's cases they are complicated with fractures of the base and parietal bone, and Hewitt has seen but one instance of such separation without fracture.

Out of twenty-three cases the coronal suture was separated in seven, the lambdoid in six, the sagittal in four, the petro-occipital in four, the temporo-parietal in one, and the spheno-parietal in one. The prognosis of such injuries is unfavourable, because the violence necessary to produce the accident must be extreme.

As each, separately, is likely to be attended with fracture of the skull, the treatment is the same as for that injury.

Depressed fracture.— From what has been said as to the want of special gravity of fractures of the cranial bones *per se*, it is obvious that the only fractures important to be recognised as such are those attended with depression; and with these also the amount of depression is of little importance in itself, but of great moment with reference to the injury of the brain or membranes which it may involve. It is plain, then, that so far as fractures of the skull require surgical interference, the depressed fracture is that in which the diagnosis is most important. The existence of depressed fracture is not always easy to ascertain; for if it be simple, the thickness of the scalp, augmented by effused blood or inflammatory products, renders the recognition difficult, unless the depression be very great. As, however, operative interference is not indicated here, unless other symptoms be present, accurate diagnosis is of secondary importance, and in cases of necessity doubts may be removed by an exploratory incision.

The existence of compound depressed fracture can be ascertained by the use of the probe or finger nail; but even here an unevenness of the bones, or the presence of a cranial suture in the wound, may render a mistake possible.

Depression of the cranial bones may exist without fracture. This occurs in children while the bones are soft, and may exist to a considerable degree (Erichsen).

Concussion, Contusion, Laceration, and Compression of the Brain.

Since fractures of the cranial bones do not, as has been already remarked, present in themselves any special dangers, save those which the existence of large

patulous veins predispose to, it is necessary to consider very fully the conditions of the brain which lend peculiar gravity to injuries of the head.

Concussion may be defined as a shock or vibration to the brain, and it varies in amount according to the intensity of the cause. The transient giddiness, flashes of light before the eyes, and cerebral derangement, which are perceived when the head is struck accidentally against a low doorway in the dark, represent the slightest form of concussion, beyond which the injury presents every description of severity to complete insensibility and death.

I do not mean to define concussion as a shock unattended by perceptible lesions, nor is it necessary to enter into the question as to whether death from concussion, unaccompanied by these lesions, is possible. The entire anatomical arrangements connected with the brain, its vascular supply, its serous envelope, its water-bed of subarachnoid fluid, all are meant to minimise the effects of shock. It may be, as Duret maintains, that the earlier symptoms of concussion are due to anæmia from spasm of the muscular coats of the arteries, and that a secondary result is congestion from paresis, or inflammatory dilatation of the same vessels, and with this latter condition disseminated hæmorrhages may be associated, whose presence as irritants may augment the tendency to local congestion. It will simplify the matter to state that the most minute descriptions which have been given represent the condition as one of surgical shock with the additional brain symptoms.

It is usual to contrast concussion with compression, for the purpose of differential diagnosis, but such distinction it is not always possible to make, especially just after the accident, because an injury of the head sufficient to produce compression, or other manifest lesions of the brain, must obviously, at the

same time, give rise to concussion, and the two groups of symptoms must at first be present, until those of concussion pass away, and leave those of the other conditions uncomplicated and manifest.

Concussion is generally divided into *three stages.* (1) Collapse or insensibility; (2) reaction; and (3) inflammation.

1. The evidences indicative of the first stage of concussion will usually be a quick, weak, and sometimes intermitting pulse; the breathing quiet, faint, or sighing; the skin surface cold, sometimes covered with a clammy perspiration. The sphincters usually, but not always, are able to perform their functions, and the intellect is more or less interfered with. Nevertheless, it is possible, except in the very severe cases, to rouse the patient by addressing him in a loud voice. In addition to these usual symptoms, the following signs are also sometimes present: On making the patient sit up the carotid arteries are seen to throb with more than usual force, and the ratio between frequency of pulse and respiration may be disturbed, a sign, as Mr. Colles observes, of grave import; while there is also in many cases a tendency to sleep.

2. Reactionary signs are usually ushered in by vomiting (which is therefore looked upon not only as a valuable diagnostic symptom, but as one of favourable signification), and, after a time varying from minutes to hours, or days, the patient's full intellectual powers return. This second stage may be succeeded by convalescence, but in other cases the reaction becomes excessive, and after a time may develop into intracranial inflammation, a sequence which is most likely to occur when the concussion has been complicated by some injury of the brain or its membranes. There is no doubt, however, that death may take place in the first stage and also in the second, although post-mortem examination may not show proof of the existence of

true inflammation by the presence of its usual products.

3. Inflammatory symptoms sometimes appear as soon as the third day, whilst in other cases their advent is postponed to the twelfth or fifteenth.

The diagnosis of concussion, as usually understood, that is, of the first stage above described, is of more scientific than practical interest, because the indications for *treatment* are chiefly negative, and a full recognition of the condition implies an abstention from surgical interference, while the setting in of reaction is awaited or encouraged by the mildest measures. Perfect rest must be enjoined, accompanied by the application of warmth to the surface, and the administration of hot drinks or mild stimulants. It must not be forgotten that the amount and duration of application of these external remedies must be regulated by the surgeon's intelligence, and not by the patient's blunted sensations.

Cerebral irritation.—In connection with concussion may be mentioned the condition described by Erichsen as cerebral irritation. "The bodily symptoms are as follow: The attitude of the patient is most characteristic; he lies on one side, and is curled up in a state of general flexion. The body is bent forward, the knees are drawn up on the abdomen, the legs bent, the arms flexed, and the hands drawn in. He is restless, and often, when irritated, tosses himself about. But, however restless he may be, he never stretches himself out, nor assumes the supine position, but invariably maintains an attitude of flexion. The eyelids are firmly closed, and he resists violently every effort made to open them; if this be effected, the pupils will be found to be contracted. The surface is pale and cool, or even cold. There is no heat of head. The pulse is small, feeble, and slow, seldom above 70. The sphincters are not usually

affected, and the patient will pass urine when the bladder requires to be emptied; there may, however, though rarely, be retention. The mental state is equally peculiar. Irritability of mind is the prevailing characteristic. The patient is unconscious, takes no heed of what passes, unless called to in a loud tone of voice, when he shows signs of irritability of temper, or frowns, turns away hastily, mutters indistinctly, and grinds his teeth. It appears as if the temper, as much as or more than the intellect, were affected in this condition. He sleeps without stertor.

The course taken by these symptoms is as follows: After a period varying from one week to three, the pulse improves in tone, the temperature of the body increases, the tendency to flexion subsides, and the patient lies stretched out. The mental state also changes. Irritability gives way to fatuity; there is less manifestation of temper, but more weakness of mind. Recovery is slow, but, though delayed, may at length be perfect, although in these, as in all other cases of cerebral disturbance, ulterior consequences may be manifested.

The symptoms that have just been described usually follow blows upon the temple or forehead, and probably in many cases may arise from, or are associated with, lacerations of the cerebral substance, more especially of the grey matter.

Although this condition is familiar to every surgeon, it is plainly a prolonged variety of concussion, and I should prefer confining the use of the word "irritation" to cases in which the disturbance in the brain is indicated by some more special peripheral symptoms.

Concussion may terminate fatally without reactionary signs, and in such cases more or less contusion, laceration, and localised congestions will probably be revealed by post-mortem examination.

Some of the early writers have held that death may occur without manifest intracranial lesion, a view earnestly, and I think successfully, combated by Sir Prescott Hewitt.

Cerebral inflammation. — Inflammation of the brain or its membranes was formerly described as the third stage of concussion, but in some cases it may arise from an injury in which the ordinary signs of concussion are absent.

The *symptoms* of cerebral inflammation may well be classified, as Russell Reynolds has done, into (*a*) sensorial, (*b*) motorial, and (*c*) mental. At a varying period after the injury the patient complains of headache, and intolerance of light. The face is flushed and the conjunctivæ injected. He is restless and sleepless, whilst the pulse and temperature indicate inflammatory mischief. The tongue is moist and sometimes thickly coated, and nausea may be present. Later on, the headache will be succeeded by delirium, and local spasm or paralysis of certain groups of muscles, amounting often to complete hemiplegia, will indicate the part of the brain affected. This delirium will often pass into coma, sometimes preceded by convulsions, or by a violent rigor, which symptom is of value as an indication of suppuration. In the comatose condition all the natural functions are suspended; urine is involuntarily voided, whilst at the same time there may be retention, a point of practical importance. Control over the sphincter ani may also be lost.

Local paralyses are indicated by dilated pupil, stertor in breathing, and more or less hemiplegia, and, in fact, the case resolves itself into one of compression, and the symptoms may be due to inflammations of the dura mater, of the arachnoid, of the subarachnoid spaces, or of the cortical brain substance itself. How far the presence of the earlier

inflammatory products, such as serum or lymph, can produce compression may be a debatable subject, but there is no doubt that the presence of pus can give rise to pressure effects which disappear on its removal.

The *treatment* of such a case from the beginning must be conducted on general principles. Excessive reaction is to be kept in check by rest, cold to the head, and purgation, with perhaps leeching or bleeding, and, as soon as the rise in temperature and other symptoms point to the advent of inflammation, a more strictly antiphlogistic treatment must be carried out, and the use of mercury internally offers the best hopes of staying or resolving the inflammation. When symptoms of compression supervene the propriety of surgical interference must be at once considered. If the inflammation have followed upon depressed fracture, its onset will suggest the removal of the probable cause, but should the signs present themselves at an early period, so that they may be considered due to meningitis or encephalitis, with exudation of lymph or serum, interference is useless. At a later period, when there are reasonable grounds for concluding that the pressure is caused by pus, and when trustworthy indications exist as to its site, the surgeon is not only justified, but called upon, to afford his patient a chance of recovery by endeavouring to remove the purulent effusion.

Contusion of the brain.—There are few cases of fatal injury to the head in which some contusion is not discernible ; contusion as evidenced by extravasation of blood into the brain substance, with consequent damage to the same. When the skull receives a severe blow the brain may exhibit directly at the point affected a contusion ; but, as the effect of the injury is also to throw the brain against the opposite side of the vault, it is very common indeed to find

the cerebral contusion on that side. But during the vibration or concussion which the brain receives, extravasations at various other points occur, either directly as the result of the shake, or subsequently, from alterations in vascular pressure and tension.

We accordingly find two classes of brain contusion; one circumscribed, either as a single portion of brain infiltrated with blood, or an agglomeration of similar smaller effusions.

In the second variety, extravasations more minute are disseminated on the surface or through the surface of the brain. If the accident has preceded death by some time these spots may be found in process of change, and the colouring matter of the blood may stain the brain substance for some distance. In the smaller ones absorption may have commenced, whilst in the larger ones softening and disintegration may be present, and a ragged irregular surface like an ulcer may be the result. In most cases at the same time extravasation into the membranes will be present, the pia mater and arachnoid being both probably torn. This contusion of the brain occurs more frequently at the base or anterior lobes than on the upper surface.

As regards *symptoms*, it is obvious that they must be intermingled with those of concussion and compression, probably often obscuring the differential diagnosis between those two states. It has been said that local tonic spasm, extreme restlessness, constant tossing about, are more or less characteristic of contusion; but from what has been said it is plain that, unless the injury implicate one of the motor areas, and that immediate disturbances of the group of muscles connected with that area exhibit themselves, exact diagnosis must be extremely difficult, or, as some authorities consider, impossible (Hewitt). Any direct treatment, consequently, can seldom be practised,

the principal indication being to prevent the occurrence of encephalitis or meningitis, the remote effects being acute or chronic abscess.

Laceration of the brain may occur in the same class of cases that cause contusion, and I have frequently seen the first form of contusion accompanied by laceration. It may also occur from direct violence with depressed fracture or foreign body, and may be attended with, in some of these cases, escape and loss of brain substance. A considerable quantity has been thus lost and yet recovery known to follow.

The *symptoms* of these accidents, in addition to those of concussion or compression, will depend on the particular part of the brain injured, and probably vary according to the time the patient may survive.

Other **wounds** of the brain, of the varieties met in other regions of the body, are described, and range from the slightest puncture to considerable laceration and destruction, but they need no detailed description; and the old maxim that no injuries are too grave to be despaired of or too slight to be despised, is found to have as much force now as when it was uttered. There is now no reason to doubt the authenticity of Harlowe's celebrated case, where a crowbar passed through the side of the middle fossa of the cranium from below and emerged close to the vertex, the patient recovering with impairment of intellect, and living for twelve years after.

Compression.—Compression from inflammation having been described, it is well now to treat of the condition in general, with its causes and its differential diagnosis, and to suggest the treatment suitable to the various cases. Compression may arise from either injury or disease, and its causes may be thus enumerated:

Traumatic causes.—Depressed fracture, pus, serum or lymph, foreign body, effused blood.

Tumours, including syphiloma, carcinoma, sarcoma, glioma, scrofuloma, osteoma, angioma, psammoma.

Symptoms.—When compression is the result of injury, as when it accompanies depressed fracture, the symptoms at first are necessarily mingled with those of concussion. The extent of the fracture affords, to some extent, a measure of the amount of violence used, and of the shake to the brain which must have resulted; but, as I have already said, it will not be until the signs of concussion pass away, that those of uncomplicated compression will be recognised. Sometimes, even then, a difficulty of diagnosis will remain, for, in the reactionary stage of concussion, symptoms may arise which it is difficult, if not impossible, to distinguish from those of compression. Amongst the most universally acknowledged signs are: Complete insensibility (coma); full, slow, and labouring pulse; stertorous breathing, and in the worst cases whiffing respiration, with puffing of the cheeks. The skin will be warm and sometimes flushed; the pupils, or one pupil, usually dilated and insensible to light; nausea or vomiting absent; bladder and sphincter paralysed; and primary hemiplegia more or less marked.

The symptoms of the two states in parallel columns are quoted here from Agnew, with slight modifications.

Concussion.	*Compression.*
Unconsciousness is incomplete; patient can be made to answer, though it may be briefly, and in simple words.	Complete unconsciousness; may scream into patient's ear at the top of the voice, but will receive no answer.
Special senses, though greatly blunted, are not abolished.	Special senses entirely suspended.
Power of movement not destroyed; if the position of a limb be changed the patient will resist or bring it immediately into the original position.	Complete or partial paralysis; in most cases hemiplegia.

Concussion.	*Compression.*
Respiration is quiet and feeble.	Respiration full and noisy.
Pulse feeble, frequent, and intermittent.	Pulse full and slow, and sometimes labouring.
The stomach sickens and rejects its contents.	The stomach is insensible to any impression; no nausea or vomiting.
The fæces may be discharged incontinently, as may also the urine, though not usually.	Bowels are torpid, and the bladder incapable of emptying itself, though the urine may escape by overflow.
Deglutition little impaired.	Deglutition difficult or impossible.
Pupils variable, though generally contracted; the eyelids somewhat open.	Pupils variable, though generally much dilated, and the eyelids closed.
Temperature of the body less than natural.	Temperature almost natural, a little below the normal standard.

"No surgeon, however, will have been long engaged in hospital practice before he discovers that these sharp differential distinctions are subject to great variations and modifications. Notwithstanding these irregularities, however, there remains a large number of cases in which the time-honoured distinctions hold good, and possess, therefore, a practical value."

It must also be borne in mind that the word compression comprehends every variety of brain pressure, from that produced by a spicule of bone to that of a large abscess or malignant growth. Some of its causes may be complications of concussion, for example, contusion, laceration, and ruptured blood-vessels, which have been enumerated as such. But as compression is the more chronic state, and is that in which, whilst surgical interference may be necessary, more time is available for consideration, it is well to dwell on the various conditions which may co-exist, or which may successively present themselves, with a view to diagnosis and treatment.

Thus, compression is an extremely complex state,

and its symptoms, prognosis, and treatment differ so widely in cases at the two extremes, that, in my opinion, a further division of the term is greatly to be desired. Those cases, for example, which arise from a spicule of bone, a small foreign body, a localised inflammation, or other limited lesion, I propose to designate by the term "*local cerebral irritation*," leaving the more comprehensive word "*compression*" to include those cases in which extensive pressure is manifested either by cause or effect. Such a division would be more in consonance with modern ideas of the localisation of cerebral functions.

Fig. 87.—Compression of the Brain due to extensive Extravasation of Blood. (After Hutchinson.)

Terminations of compression. — The symptoms of compression may disappear after a certain period, sometimes spontaneously, sometimes following on treatment; but in other cases they persist, and a fatal termination may result, without any indication for operative interference.

Differentiation of the varieties of compression.—As has been seen, the causes of compression vary, and it is important to differentiate these. If the symptoms of compression exist from the beginning, however those symptoms may be obscured by the signs of concussion, it may be suspected that depressed fracture, foreign body, or some serious brain lesion exists, and if the history of

the case, or the apparent cause of the condition, such as a fall on the head, be accompanied by the signs of compression, we are safe in assuming the presence of a depressed fracture or a foreign body; whilst if the signs of concussion disappear, and those of compression gradually supervene, after the lapse of a period from one to forty-eight hours after the injury, extravasated blood is probably the cause. Such cases as the following are not uncommon, and they may sometimes involve the surgeon in unmerited blame:

A man is thrown from a vehicle on his head and is brought to the nearest surgery or hospital in a state of concussion. He recovers more or less quickly, and insists on proceeding homewards, contrary to the urgent advice of the surgeon. Perhaps he hastens reaction by taking stimulants, and in some hours afterwards he becomes drowsy, stupid, and falls from his seat. Complete insensibility and all the other signs of compression supervene, and death closes the scene. What is the explanation? The middle meningeal or other vessel had been ruptured at the time of the accident, and during the collapse state of concussion, when the heart's action was more or less in abeyance, a clot formed at the seat of injury, which stemmed the tide of extravasation. But with the establishment of reaction (perhaps too vigorous) the clot had been swept away, and the cerebral hæmorrhage proceeded unchecked, either between the bone and dura mater, or upon the surface, or within the substance of the brain itself, and that hæmorrhage produced the fatal coma.

Compression by serum or lymph may be suspected if the symptoms arise in the early stages of encephalitis or meningitis, and in these cases it is fortunate that diagnosis is not so important, as there can be no surgical interference, and a reliance on the general remedies can alone be inculcated.

At a later period, when inflammation, in whatever structure it may originate, has produced suppuration, a condition which is indicated by rigors, by the presence of Pott's puffy tumour (an appearance so rare that many experienced surgeons have never seen

it), or by the state of the bone if it be bare, the existence of the effused pus may be diagnosed, and its probable position should be considered. It may have been formed between the skull-cap and the dura mater, as when the puffy tumour is present, or where the bone is manifestly dead; or it may be diffused upon the surface of the brain, or circumscribed between adherent membranes, or in the subarachnoid spaces, or in the brain substance itself.

Our knowledge of the modern topographical anatomy of the brain may lead us in doubtful cases to suspect a pressure limited to a particular spot. In such cases operations may be attempted with hope, as they have been performed with success.

It must be remembered that compression may exist to a considerable extent, especially when slowly induced by the gradual formation of matter, or the slow growth of a tumour, and that, nevertheless, few of the symptoms described as belonging to compression will be manifested, or they only mark the termination of the case. On the other hand, it may occur that though all the symptoms are present, a post-mortem examination gives very negative proof of the existence of any appreciable compressing cause.

It is in cases where coma is not so marked or persistent, where limited primary spasms or paralyses are present, where aphasia, or the implication of certain groups of muscles point to an irritation, such as that which a localised compression may produce, that operative interference is most hopeful, and, although these symptoms may be almost altogether absent, yet the existence of an obvious cause, such as in punctured fracture, or foreign body, will at once suggest operation, and encourage hope of success.

With regard to **peripheral indications of centric lesions,** it is desirable to direct attention to the great difficulty of recognising these in many

cases; but this difficulty may often be met by a due consideration of the locality of the injury, and its anatomical relations. Thus, for example, fissure of the petrous bone is almost with certainty indicated by what have been called the triad of symptoms, namely, bleeding from the ear, deafness, and Bell's paralysis. If unconsciousness from any cause be present, only one of these can be recognised with certainty.

Again, if the patient be conscious, the diagnosis of hemiplegia is attended with no difficulty, and spasm or paralysis of any groups of muscles functionally associated, can be easily ascertained; but if he be comatose, it requires both experience and care to recognise their presence. Slight facial palsy is, under any circumstances, difficult to detect; but if it be pronounced, the whiffing respiration, the passive alæ nasi, the twisted mouth, or the permanently open eye, may prove its existence even in insensibility. This condition is still further obscured if symmetrical or if a bi-lateral lesion, differing in intensity in the two hemispheres, affect the opposite nerves to a different extent. The presence of hemiplegia affecting the limbs in such a case is also difficult to ascertain. If the paralysed arm or leg be raised and allowed to drop, it falls with a deadness that may, as compared with that of the opposite side, be recognised by the experienced surgeon. But, on the other hand, this may not be so, and it may require close and continuous observation to satisfy the surgeon that movements take place occasionally on one side, and that the limbs of the opposite side remain persistently motionless.

Pathological conditions found after death from head injuries.—The most usual are (1) bone disease with necrosis or osteo-phlebitis and remote evidences of pyæmia, or with secondary intracranial mischief; (2) arachnitis, localised or extensive, with serum, lymph, or pus in the cavity of the arachnoid;

(3) inflammation with lymph or puriform fluid in the subarachnoid spaces; (4) inflammation of the brain substance itself, with or without suppuration.

Although it is not always possible during life to differentiate these conditions, there are certain symptoms which appear more prominent when one or other of them predominates. Thus, if the bone injury lead to pyæmia, in addition to the local signs, the occurrence of repeated rigors is much insisted on by Hutchinson as a pathognomic sign. When secondary hemiplegia occurs, accompanied by rise of temperature, quick pulse, headache, delirium, intolerance of light and sound, restlessness and sleeplessness, and other signs of meningitis, the same authority believes that the arachnoid is especially the seat of the disease. Inflammation of the subarachnoid spaces, with purulent exudation, he considers follows injuries of the base, especially where nerve trunks are involved close to their cerebral origin, and this condition is indicated by gradual advance of symptoms, hemiplegia being absent. Dilatation and fixation of the pupil or pupils, accompanied by external strabismus, indicate implication of the third pair of nerves, while if the tongue be thickly coated, the fifth pair is involved; and if there be a tendency to pneumonia, most probably functional lesion of the pneumogastric has occurred. Inflammation of the brain substance occurs primarily as the result of injuries to its substance, and secondarily by extension from its membranes.

Encephalitis and meningitis.—When intracranial inflammation supervenes, as either the result of concussion, or from direct injury of the brain or membranes, as in contusion, laceration, or fractured base, it is not always possible to say how far the symptoms are those of meningitis or encephalitis, and at an early period the importance of a differential diagnosis is not

very great, the treatment being the same for both conditions. Later, when cerebral abscess, or localised meningeal suppuration may be present, the indications for interference will be much the same in both cases, and even when abscess accompanies or follows diseased bone where it might be reasonably expected to occupy a superficial position, such as between the bone and dura mater, it is not unfrequently found in the brain substance itself.

The general treatment for encephalitis and meningitis has already been described under the head of traumatic intracranial inflammation. Post-mortem appearances in such a case vary very much. If the dura mater be alone affected, consequent on traumatic osteitis or its sequelæ, thickening and increased vascularity, or even localised sloughing of the membrane may be found, as in periostitis elsewhere. If the arachnoid be involved, the inflammation is usually diffuse, and may extend over both hemispheres, and the cavity of the membrane may contain lymph or puriform exudations of a yellowish-green colour. This condition may be complicated by the existence of fibrinous masses or pseudo-cysts, the result of preceding extravasation of blood. When the pia mater is affected, there may be extensive puriform effusion with great congestion of the vessels. Sometimes the matter in the subarachnoid spaces seems to gravitate downwards along the larger vessels towards the base of the brain, or the medulla oblongata. Encephalitis may follow meningitis, or it may be primary, and may affect the cortical or medullary structures, or both. The grey substance may be softened, and be of a dark leaden hue. The white substance resists the softening and disintegrating process to a greater extent than the grey matter, except as the result of a direct injury.

Cerebral abscess may be described as of two

kinds, acute and chronic; the first variety following immediately on encephalitis, and the second manifesting itself at a considerable period after the receipt of the injury, and with few symptoms of antecedent inflammation.

If, in the course of a case of encephalitis, a well-marked rigor occurs, and symptoms of irritation of, or pressure upon, one or more of the motor areas exhibit themselves, or at a more remote period similar symptoms are recognised, the presence of cerebral abscess may be suspected. The existence of optic neuritis, too, may lend an additional aid to the diagnosis.

Injuries to the Cranial Nerves.

First pair.—The olfactory nerves can scarcely be materially injured, except in fractures of the base, and here the nerve injury is of little importance. Loss of smell has occasionally followed injuries of the vault, possibly from contusion of the nerve or adjacent portion of the brain.

The **second pair** may be torn across, or contused, or pressed on by broken bone or extravasated blood, and loss of sight, more or less complete, is the immediate result. This may be permanent, or recovery may follow when the nerve lesion is produced by contusion or extravasated blood.

Third pair.—These nerves are very frequently affected in injuries of the head, and the symptoms vary with the amount of injury; thus, irritation may produce spasm, as indicated by contracted pupil, internal strabismus, and partial lagophthalmos, while complete paralysis of the nerve is shown by the opposite set of symptoms.

Fourth pair.—No special lesion of this pair has been noticed, or, at least, no symptoms described in reference to it.

Fifth pair.—It has been mentioned that a thick white coating of the tongue, quickly following on cranial injury, probably depends on some structural or functional disturbance affecting this nerve. If this be associated with want of sensation, including not only the tongue, but the side of the face and conjunctiva, the diagnosis of injury of the trifacial is more certain. At a more remote period opacity or ulceration of the cornea has been known to occur. The paralysis of the fifth may be temporary or permanent, according to the cause.

Sixth pair.—Paralysis of this nerve is likely to occur in fracture of the base; internal strabismus will indicate the injury.

Seventh pair.—The portio dura and auditory may be injured together, as manifested by deafness and facial palsy, or either separately may be involved, as shown by the single group of symptoms belonging thereto.

Eighth pair.—From their position they are not likely to be affected, except in fractures of or extravasations about the base. Difficulty in swallowing will point to the involving of these nerves, whilst, as has been mentioned, unusual tendency to pneumonic complication will strengthen the diagnosis.

The **ninth pair** of nerves will be probably implicated in the same class of lesion, and be indicated by paralysis of the tongue.

Hernia Cerebri.

When a portion of the cranial vault is removed by injury or by operation, and an aperture thereby made in the dura mater, a fungous mass may gradually protrude, to which the name hernia or fungus cerebri has been assigned.

True hernia cerebri, an outgrowth from the brain itself, forms a more or less mushroom-shaped tumour,

attached by a pedicle situated at the opening in the skull, and presenting an expanded portion which projects above and around the orifice. True brain substance has been found in this, also blood and granulation tissue; but, nevertheless, it has not been fully explained how such a protrusion occurs, and how it develops so rapidly. Probably it may arise from hyperæmia extending in the direction of least resistance, leading to a projection of brain substance and inflammatory products, associated with irregular vascularity and fluid accumulations in the substance of the contiguous brain. This form of protrusion may be vascular and pulsatile, firm or soft, and sloughing of the surface may occur synchronously with the growth. It is a very fatal complication, about seventy per cent. of the cases dying (Nancrede).

As hernia cerebri seems to arise from irritation, and from want of the natural pressure of the bone, the rational *treatment* is the removal of all the causes of that irritation, and the use of compresses of lint or cotton, antiseptically prepared, and strict attention to cleanliness.

Terminations of injuries of the head.—(1) Recovery, which may be partial or complete; (2) death, immediate or subsequently, from the remote effects.

There is scarcely any injury of the skull, as has been already remarked, from which complete recovery may not take place; but in a number of cases, larger, perhaps, than may be reported, recovery, with some appreciable morbid conditions, occurs.

Thus, immediately or at a remote period, the patient may suffer from insanity, epilepsy, diabetes, hemiplegia, or other partial paralysis, or from impairment of some of the special senses. Even without such perceptible lesions, a certain delicacy or irritability of brain may result, which will display itself

by alterations of temper, especially when alcoholic drinks have been taken, or when the intellect has been over-exercised, or the emotions abnormally excited. Many of the complications may be the remote causes of death. When a fatal termination occurs immediately it is probably due to severe concussion, contusion, or laceration of brain, or to compression from extravasation of blood. But if death occur later on, inflammation, with its products, will be responsible. If recovery from the accident and from its immediate consequences occur, epilepsy or diabetes may destroy life after the lapse of some months or years, injuries of the occipital region being most frequently the causes of the latter.

Trephining.

The operation of trephinin which is meant to include all kinds of interference with the bone, whether with the trephine, Hey's saw, the forceps, or the elevator, may be required in the following cases: (*a*) Compound depressed fracture, when the amount of depression exceeds the thickness of the bone; in other words, where a probe can be slipped in on the surface of the displaced fragment beneath the undepressed surrounding margin (Hewitt). There is one exception to this rule. In children the bone is rarely extensively splintered, the dura mater is more pliant, and the brain is more tolerant of pressure, and, therefore, in these cases trephining may be delayed till symptoms appear. (*b*) In punctured fracture; (*c*) in simple depressed fracture, with grave symptoms persistent; (*d*) when a foreign body is present; (*e*) when dead bone exists as the result of injury, with denudation of membranes or osteo-myelitis; (*f*) when blood clot occurs between the bone and dura mater, if diagnosed and accessible; (*g*) when intracranial, circumscribed, and

localised suppuration is detected, with symptoms of compression or irritation; (*h*) remotely, in point of time, if persistent epilepsy, or insanity, or localised incurable headache follow, as the result of depressed or punctured injury, or if the symptoms point to a limited and removable source of irritation; (*i*) pond and gutter fractures, if compound, hold the same position as compound depressed fracture, and, if they be simple, operation may still be necessary.

The contra-indications to operation are, *first*, very profound coma or other symptoms, which may indicate that the cause of the condition is extreme extravasation of blood into or on the surface of the brain, or fracture of the base of the skull. *Secondly*, the situation of the injury, as that of the orbits, or of the roof of the nose, though in these cases the removal of a foreign body or of loose fragments of bone would not be contra-indicated. *Thirdly*, trephining over the sutures is inadvisable, in consequence of the firm attachment of the dura mater in these situations to the bone; but this may be disregarded if the indications for the operation be imperative. *Fourthly*, trephining over the venous sinuses or course of the meningeal arteries is to be avoided, if possible. *Fifthly*, the presence of motor indications, as spasm or paralysis on *both* sides of the body, pointing to lesions of the two hemispheres, also contra-indicates operation. And, *sixthly*, trephining in a case of any injury of the cranium with insensibility is not to be contemplated until the other great cavities have been thoroughly examined, and the presence of lethal lesions in them negatived.

From many observations I have made, and from the study of collected cases in which epilepsy, insanity, dementia, and other mental troubles have followed upon unrelieved depressed fractures, I believe that, if cases of depressed fracture of the skull left to nature

could be subsequently traced, they would afford a powerful argument for primary trephining; and it must be borne in mind also that this operation in compound depressed fracture can scarcely add to the risks of osteo-phlebitis, which the procedure has been credited with producing. A more important plea for the safety of the operation is afforded by the results in surgery of modern antisepticism carried out with rigorous precautions. The dangers of septicæmia from operative interference are minimised, and in any case, where it seems necessary, the operation may be thus performed without running the risk of being held accountable for any subsequent want of success.

Cerebral topography in relation to surgical injuries.—Without dwelling on the vexed question of localised cerebral functions, there is no doubt that there exists a connection between certain areas of the brain, motor centres, and certain peripheral regions, sufficient to afford in many cases an indication of localised brain lesion. To give practical effect to the conclusions which these views point to it is necessary first to be acquainted with these centres.

Motor centres of the cortex.—The following description from Treves' "Surgical Applied Anatomy" briefly indicates these centres, according to the views of the three highest authorities.

"*According to Charcot*, (1) centre for movements of the tongue at the posterior end of the third frontal convolution and contiguous part of the ascending frontal convolution; (2) movements of lower part of face at the lower end of the two ascending convolutions; (3) centre for fore-arm and hand on the middle third of the ascending frontal convolution; (4) centre for movements of the lower limb on the upper third of the ascending frontal convolution and upper two-thirds of the ascending parietal convolution. *According to Hitzig*, (1) motor centre for

upper limb at upper part of ascending frontal convolution; (2) motor centre for lower limb on ascending frontal convolution, just below preceding centre; (3) motor centre for facial muscles at middle part of ascending frontal convolution; (4) centre for muscles of mouth, tongue, and jaws at inferior part of ascending frontal convolution. *According to Ferrier*, (1) centre

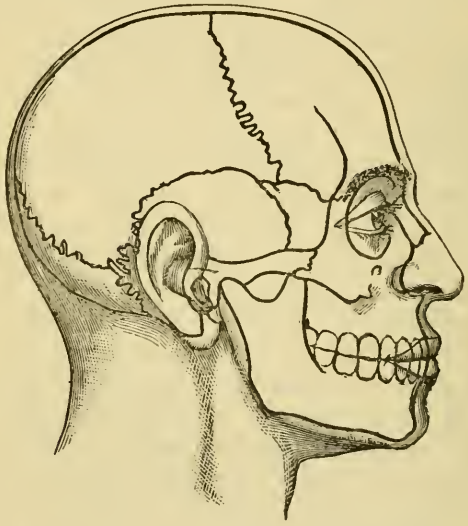

Fig. 88.—Diagram to show the Relation of the chief Cranial Sutures to the Surface.

for rotation movements of head and neck at posterior end of first frontal convolution; (2) centre for muscles of face at posterior end of second frontal convolution; (3) centre for articulate language on posterior part of third frontal convolution; (4) centre for upper limb at upper end of ascending frontal convolution; (5) centre for lower limb on upper two-thirds of ascending parietal convolution and part of superior parietal lobule."

To make this cerebral localisation useful to the

surgeon it is necessary to give the guiding points of the head, which indicate the exact positions of the fissures, convolutions, and motor centres alluded to in the preceding quotation.

Relations of the brain to the skull (Treves).—"The lower level of the brain in front corresponds to a line drawn across the forehead just above the

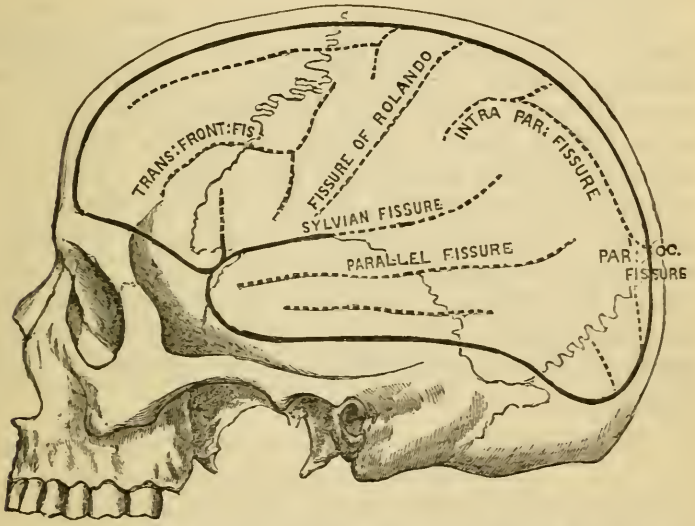

Fig. 89.—Diagram to show the Relation of the Main Fissures to the Surface of the Skull. (From Treves' "Surgical Applied Anatomy.")

eyebrows. At the side of the head it corresponds approximately to a line drawn from a point half an inch above the external angular process of the frontal to the upper part of the external auditory meatus. A line drawn from this latter spot to the occipital protuberance corresponds to the lower level of the posterior lobe, while below that line will lie the cerebellum. The commencement of the Sylvian fissure corresponds to the pterion. Its ascending limb is parallel to, and immediately behind, the

coronal suture. Its posterior or horizontal limb runs backwards across the upper margin of the squamous suture. The external parieto-occipital fissure is a little in front of the lambda. The fissure of Rolando is some way behind the coronal suture, and is not quite parallel to it, being a little less than two inches behind the suture above, and a little more than one inch behind it below.

The temporo-sphenoidal lobe lies below a line drawn horizontally backwards from the external angular process. To find Broca's convolution (the posterior part of the third left frontal convolution), a horizontal line is drawn backwards from the external angular process for two inches. The convolution is three-quarters of an inch above the end of this line. The upper borders of the optic thalamus and corpus striatum are about on a level with the top of the pinna. They are situate opposite the temporal region, and the anterior limit of the corpus striatum about corresponds to the pterion." (*See* Fig. 89.)

IX. DISEASES OF THE SPINE.

Herbert W. Page.

Spina Bifida *

is the name given given to "certain congenital malformations of the vertebral canal, with protrusion of some of its contents in the form of a fluid tumour. With very rare exceptions, the malformation affects the neural arches of the vertebræ, and the tumour projects posteriorly; in rare cases, however, the malformation involves the bodies of the vertebræ, the tumour in such cases protruding anteriorly into the thorax, abdomen, or pelvis between the lateral halves of the bodies affected." The bifid condition of the neural arch is essentially due to defective development of that part of the mesoblast from which the structures closing in the vertebral furrow are derived. The result is a gap, fissure, or cleft in the vertebral arches, whereby the spinal canal at the affected points remains open.

The commonest *site* of the defect is in the lumbo-sacral region, but it may rarely be found in the upper cervical, and much less often in other parts of the column. The cleft may vary enormously in size, and involve the arch of one vertebra or of many. The fluid tumour usually occupies the middle line, and presents every variety, both in size and appearance.

There are three main *varieties* of spina bifida: (1) those in which membranes alone protrude, *spinal*

* Quotations in this part of the article are from the recent "Report of the Committee on Spina Bifida," Clin. Soc. Trans., vol. xviii., to which the reader must refer for the best information on the subject.

meningocele; (2) those in which "membranes, together with the spinal cord and its appertaining nerves, protrude, *meningo-myelocele;*" and (3) those where there is "protrusion of the membranes, together with the spinal cord, the central canal of which is dilated so as to form the sac cavity, the inner lining being constituted by the expanded and atrophied substance of the cord, *syringo-myelocele.*" The second is by far the commonest, the last is the rarest.

Symptoms.—Associated very often with the spina bifida, and indicative of the implication of nerve elements in the tumour, are paralyses, more or less, of the lower limbs or sphincters, some degree of club foot, talipes equino-varus being the most frequent, with perhaps a generally stunted appearance of the whole limb, which may be cold and blueish. There is often also hydrocephalus, and pressure on the sacral tumour may increase the distension of the head and cause convulsions or other grave disturbances.

The form and size of the *sac* vary enormously. It is usually about the size of a Tangerine orange at birth (Fig. 90). "In form sessile, somewhat constricted at the base, circular, ovoid, or cordiform in outline, these tumours occasionally present a slight median longitudinal furrow, or sometimes a more localised depression at or near the summit, the so-called umbilicus. The latter indicates the spot at which the spinal cord meets and becomes incorporated with the posterior wall of the sac; but whilst its presence indicates that the tumour is a meningo-myelocele, its absence cannot be held to show the contrary. The same is true of a median furrow."

The coverings of the sac also show great varieties. "It is very seldom that a normal cutaneous covering exists over the whole protrusion. As a rule, the base alone is covered with normal skin, while in the rest

of its extent the covering consists of a thin, white, glistening membrane-like tissue. In some specimens the skin ends abruptly, in others it merges gradually into the membrane noticed. More rarely, however, the cutaneous covering is continuous over the whole tumour." The cleft most often involves several vertebræ, "most usually the last lumbar and all the sacral." "The actual extent of the protrusion forms no certain criterion of the extent of deficiency in the neural arches."

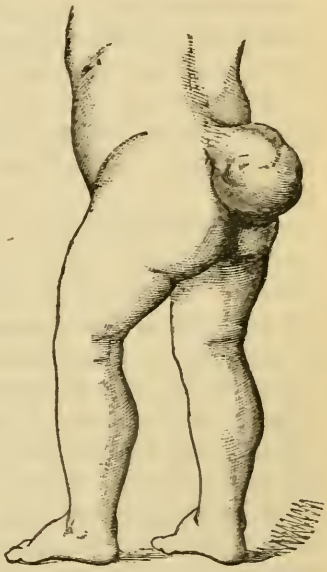

Fig. 90. – Spina Bifida.

In the second and commonest variety it has been mentioned that a depression or furrow indicates the spot where the cord meets and becomes incorporated with the posterior wall of the sac. "The level at which the cord crosses the sac is variable; as a rule, it is somewhat above its centre. Occasionally, however, the cord, as it emerges from the vertebral canal, becomes immediately connected with the roof of the sac without the intervention of any space." The integrity of the central canal of the cord is preserved at this part, where there is an absence of true skin. "The nerve roots which traverse the sac arise from this intramural portion of the central nervous system. . . . The sac wall is really their source, and the nerves within the sac are the proper anterior and posterior roots." It is therefore clear that the *neural furrow* does not remain unclosed in spina

bifida. It is the *vertebral furrow* which is at fault.

Prognosis.— The general tendency of spina bifida is to increase in size, and for the coverings to become thinner and thinner until they burst; cerebro-spinal fluid is poured out, and the child dies from convulsions or meningitis. In the smaller tumours, however, where probably the cleft is small, the coverings are of skin all over, and there is simply a meningocele, spontaneous recovery is by no means rare; that is to say, the fluid gets less, the walls shrivel and contract, and it may be that the cleft is closed.

The treatment of spina bifida has always been unsatisfactory, and interference has often caused death. Success has most frequently attended the treatment of the smaller tumours, which have a tendency to spontaneous cure, and it is a question whether in all such cases the surgeon will not do wisely to be content with protecting the tumour from injury, and continuously apply gentle pressure so as to prevent increase in size. It is different, however, with rapidly increasing tumours, which are associated with grave nervous symptoms. Various methods of treatment have been adopted, such as repeated tapping, excision and ligature, and injection with simple iodine, but none of these can be recommended. We have, in injection of Morton's iodo-glycerine solution (iodine gr. x, iodide of potassium gr. xxx, glycerine ʒj) a method of setting up a process of cure which consists in gradual shrinking of the tumour, and which closely imitates that which occurs spontaneously. "The puncture into the tumour should be made at one side of the base, obliquely through healthy skin, and not through membranous sac wall. It is not necessary to withdraw any of the fluid contents of the tumour before injecting the solution."

A drachm is a suitable quantity in the majority of cases, and the injection may be repeated in about a fortnight.

"The circumstances which contra-indicate the operation are advanced marasmus, great and increasing hydrocephalus and intercurrent disease. As a rule it is well to wait until the child is at least two months old before submitting it to operation; but when the sac wall is threatening to burst treatment may be carried out earlier."

The cure of the spina bifida offers no prospect of improvement in any paralysis or talipes. Occipital meningocele hanging low down may be mistaken for cervical spina bifida. Spina bifida is more common in females than in males. The tumours may rarely be multilocular.

Congenital sacro-coccygeal tumours.—The neighbourhood of the sacrum and coccyx is a favourite site for certain congenital tumours. Of these may be named some portion of a fœtus, usually a third lower limb; tumours containing fœtal remains such as bone, cartilage, hair, and teeth, deeply seated, perhaps, and adherent to bone, often pendulous, and presenting great variety in both size and contents, sometimes associated with and liable to be mistaken for spina bifida, especially when situated higher up than usual and in the middle line; congenital cystic tumours, single or many-chambered, some of which may at one time have been connected with a sacral spina bifida, and when of large size and growing inwardly, surrounding the rectum and other pelvic organs; congenital solid tumours, fibrous, fibro-cellular, and fatty, which may start from the front of the sacrum or coccyx, attain vast dimensions, spread widely in the pelvis, and surround or displace all the organs contained therein. It is highly probable that many of these congenital tumours arise in connection

with embryonic structures, remaining in parts where the three blastodermic layers are brought into close apposition in the process of development, as it is in certain canals which become obsolete in mammalia, such as the post-anal gut, which occupies the site of these teratomata.

Many of the smaller tumours can be easily removed; but no attempt should be made to operate on those which extend deeply into the pelvis until their connection with the pelvic viscera has been as far as possible determined.

POTT'S DISEASE.

Pott's disease of the spine, often spoken of as "angular curvature," a strange misnomer, is a disease commonly of early life, which consists in inflammation and necrotic destruction or caries of some, usually the anterior, parts of the vertebral bodies and intervertebral discs, whereby the natural support given by these structures to the column is lost, and the spine above the seat of mischief falls forwards, and a projection is caused in the middle line of the back. In extreme cases, such as that shown in the accompanying sketch (Fig. 91), where the bodies of many vertebræ are destroyed, the angular projection is very great, and the stature of the patient is diminished. In company with this bone disease there is, as elsewhere, the formation of an abscess which may present itself externally in various parts.

Fig. 91.—Pott's Disease.

Pathology.—The morbid process is closely allied to, if it be not identical with, that of caries of other bones. The lower dorsal region is the commonest

site of the disease, which usually begins in the anterior part of one or more bodies, or in the epiphysial portion which lies next to the intervertebral substances. It may also begin in the intervertebral discs themselves; but wherever its precise origin, and whether we call it a simple caries or osteitis, or it be of a distinctly tuberculous nature, the process leads to softening and crumbling away of the bone, and a collection of matter is formed which consists of broken-down bone, inflammatory products, and pus, and which lies in front, or more often a little to one side of the fronts, of the bodies. The position of the abscess is determined by the seat of the disease, by the greater ease with which pus can accumulate in front than behind, a tendency, moreover, which is encouraged by the forward bending of the column. By gravitation the pus makes its way downwards along the front of the spine; the abscess assumes a pear shape, and according to the site of the disease, and the rate of increase, will be the exact point at which it ultimately appears. It may, however, remain limited to the seat of disease, and should the destructive process cease it may then dry up, and undergo the same kinds of changes as occur in old abscesses elsewhere. We shall return to the consideration of the abscesses when we have dealt with the various symptoms to which Pott's disease may give rise, and by which the surgeon should, if possible, diagnose it in its earliest stages, before the diagnosis has been made for him by the appearance of an abscess or the median angular projection.

Etiology.—Injury such as a severe spinal bend or wrench may, it is thought, have some share in starting the morbid process, by bruising an intervertebral disc or stretching the anterior common ligament; but very commonly the disease seems to begin without more definite causes than poor living

and general insanitary conditions, such as are found amongst the children of the poor. These causes will naturally be more potent for evil in children of strumous tendency, hereditary or acquired.

Symptoms.—Far too often cases of Pott's disease come under observation only when the mischief has been done, and the story is told of past ailment, and that the child's back has now "begun to grow out." There are, however, important symptoms, even in the period of indefinite ailing, which, in combination with general malaise and health failure in children, should make the surgeon tolerably certain that he has to deal with a case of Pott's disease.

These symptoms are *spinal stiffness* and *pain*. The spinal stiffness is the result of an instinctive effort on the part of the spinal muscles and ligaments to hold the column rigid, so that there may be no movement or jarring at the seat of disease. The rigidity can easily be detected by careful observation of the child's movements after it has been stripped, by watching how it will stoop to pick things up from the floor, how it will turn round in bed, or how the back comports itself when the child, flat upon its face, is raised up by the pelvis or legs. It is, therefore, very necessary to be familiar with the range of mobility and flexibility of the healthy spinal column, both in children and adults. In severe cases spinal movement is pretty sure to cause pain, which, however, is a less valuable symptom than spinal rigidity, for the inflammatory mischief is far from the surface, it is difficult for a child to localise its seat, and spinal pain is, moreover, a common complaint in other and less important maladies. It may be restricted to the seat of mischief, or in cases where the inflammatory action involves the nerves as they issue from the spine, it may be radiant in character and far removed from the site of the disease. Absence of

pain is, at the same time, very common; and it is by no means to be assumed in any case that because pain is absent there is therefore no disease. The important practical point for the surgeon to remember is this, that in all cases where there are complaints of pain in the back, or pain or other abnormal sensations in any part of the body or limbs in children, for which no obvious local cause is discoverable, he should make it his unfailing business to examine the spine to see whether there be any rigidity, for this is a symptom rarely or never absent even in the very earliest stages of Pott's disease, when treatment may perchance be of some avail in arresting the caries. The combination of the two symptoms is an almost infallible guide to the diagnosis of Pott's disease.

The spinal deformity, or median angular projection, is due to the destruction of the bodies already named, and is, to some extent, the result of a conservative process, for the gap in the bodies, which no reparative process can fill up, is nevertheless obliterated by the falling together and ultimate union of the healthy vertebræ which form the upper and lower boundaries of the diseased area. When the destruction is rapid and extensive the projection may become well marked, even in a very short time, while in others the rate of its formation may be slow; and in the lumbar region, where the bodies are large, the deformity may be very slight indeed. It is usually most prominent in the dorsal region, in consequence of the length of the dorsal spines. It may be sharp and abrupt, or little more than a general increase in the natural dorsal curve, with rather undue prominence of one or two spines. Much depends on the rate of progress and the extent of the disease. When the projection has existed for any length of time, and, indeed, while it is being formed, the posterior segments of the vertebræ, the spinous and transverse processes, the laminæ and

ribs, become anchylosed together by inflammatory adhesions, whereby strengthening of the column is effected. The fibrinous material thus produced may ultimately ossify, uniting the various parts into one bony mass. Rigidity is, of course, a marked feature in such conditions, and the wasting of the spinal muscles from disuse makes the angular projection still more noticeable than it would otherwise be. The anterior parts may also become consolidated together by thickening of periosteum and contraction of the abscess cavity, and permanent irremediable deformity is the result. At the same time the patient has been all along endeavouring to keep the head erect, and compensatory curves are formed in other regions. The sternum gets pushed forwards, the shoulders are high with the head sunk between them, and the child presents an aspect strangely old.

There are three chief varieties of *abscess* due to Pott's disease: psoas, iliac, and lumbar.

Psoas abscess is the commonest of them, and is so named from its position in the sheath of the psoas muscle. It may be regarded as an almost unfailing sign of Pott's disease in the dorsal region, although occasionally it may be met with as the result of disease lower down. Shaw has given the following admirable account of its formation and progress: "When the abscess is connected with diseased dorsal vertebræ, it encounters, in its descent, the diaphragm. But that barrier is overcome by a particular process. As the abscess comes into contact with the diaphragm and compresses it, adhesive inflammation is set up in their respective surfaces; the consequence is, that they become united over a considerable area; an opening is next formed by absorption within the boundaries of the adhering structures; the abscess then protrudes; and extravasation of pus at the margins is prevented from taking place by the firm union of the parts

encircling the opening." It next "comes into relation with the heads of the psoas muscle;" but as it "travels downwards it has to pass through a narrow strait; it is prevented from enlarging, in the fore part, by the resistance of the ligamenta arcuata," which stretch across the two origins of the muscle, "and, at the back, by that of the spine and lowest rib; hence, in order to proceed, it has to force its way in the line of the psoas muscle. That, however, can only be done by penetrating into its interior. It accomplishes this, in the first place, by inserting its most advanced part, like a wedge, between the two origins; it then splits and distends the fibres; and the psoas at length is converted into an abscess." The connections of the fascia iliaca being looser on the outer than the inner side, the abscess enlarges most freely in that direction, and now chiefly occupies the hollow between the united fibres of the iliacus internus and psoas muscles on the inside, and the crest of the ilium on the outside, When the advanced part reaches Poupart's ligament, a certain retardation occurs; and then a bulging will be observed along the line of the flexure of the groin.

Pus may also travel below Poupart's ligament as far as the insertion of the psoas, and form there a fluctuant swelling, the size of which may be modified both by position and pressure. When the pus has increased so much that there is a distinct swelling both above and below Poupart's ligament, the diagnosis ought to be a matter of no difficulty, for pressure at one part surely causes enlargement of swelling at the other. Unlike a hernia, therefore, of which no trace can be felt in the abdomen when it has been reduced, a distinct abdominal swelling can still be detected in the region of the psoas when the abscess is made solely to occupy a position above the groin. Nor is an abscess reducible with that peculiar gurgle or suddenness

which often characterises the reduction of a hernia. Unlike a femoral hernia, a psoas abscess lies rather to the outer side of the femoral vessels. In the earlier stages of abscess formation, when pus at first distends the sheath of the psoas, and little or no swelling can be felt, the presence of pus can only be suspected from the tendency of the child to keep its thigh flexed so as to relieve tension on the muscle; and should this posture lead to a suspicion of hip disease, we shall find that although extension may cause pain in the psoas region, yet, nevertheless, the thigh can be flexed on the pelvis in a manner singularly different from the limitation of that movement, independent of movement of the pelvis, which is so striking in that disease.

As an offshot very often from a psoas abscess, pus may come to lie in the *iliac fossa*, or it may gravitate there from disease of the lumbar bodies. When very large, the iliac collection of pus may make its way over the crest of the ilium, appear in the gluteal region, and seem to have no possible connection with Pott's disease. Care must, therefore, be exercised in the diagnosis of such cases, and search be made for the real cause, as also in cases where the pus has travelled into the perinæum, the ischio-rectal fossa, the back of the thigh, or other unusual sites. When the lumbar vertebræ are affected, it is common for the abscess to point in some part of the loin, when it is known as *lumbar* abscess. It makes its appearance on the surface, often as a square-shaped swelling, to the outer side of the quadratus lumborum, between the iliac crest and the last rib; and in cases where there is little or no deformity, as may happen in this region, it may be a matter of some doubt whether the abscess is really due to Pott's disease. When, however, there is disease in the dorsal region, and there is obvious deformity, rigidity, or pain, and the abscess is

either the offshoot of a psoas abscess, or has made its way to the loin because the pus could not overcome that obstacle to its descent which exists at the "narrow strait" described by Shaw, there is little difficulty in associating it with Pott's disease. In all doubtful cases, whatever may be the site of the abscess, the spine and spinal movements must be carefully examined, for local or general rigidity, even if no deformity has yet arisen, is in such cases highly suggestive of this disease.

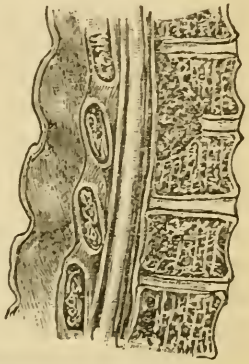

Fig. 92.—Pott's Disease involving the posterior parts of the vertebræ.

Disturbance of the spinal cord.—A remarkable circumstance in connection with Pott's disease is the rarity with which the inflammatory mischief spreads to the spinal canal, and the frequency with which the cord is undamaged even when it shares, as of necessity it must share, in the bend to which the spine is subjected in the course of the disease. The active mischief, however, is usually at the front of the bodies away from the spinal canal, and the slow rate at which the column bends allows the cord time to accommodate itself to the new conditions under which it is placed.

Unquestionable disturbances of motion and sensation, and even complete paraplegia, may occasionally be met with, and form distinct evidences that the cord or nerves have been somehow implicated. Two circumstances seem prone to contribute to this result: disease affecting the hinder parts of the bodies (*see* Fig. 92) and very rapid formation of deformity from rapidity and activity of the disease.

The symptoms rarely indicate complete destruction

of the marrow, and such as there are are rather due to pressure, either of bone or inflammatory products, than to actual myelitis. Paralysis of bowel and bladder are uncommon, and bed-sores are most rare. Paralysis of motion may affect single muscles or groups of muscles with the same nerve supply, and there may be great increase of reflex irritability. Exaggeration of knee jerk and ankle clonus are often conspicuous phenomena, which in any case of paraplegia should suggest an examination of the spinal column. Disturbances of sensation, hyperæsthesiæ or peripheral neuralgic pains are also not uncommon. Let their presence in doubtful cases lead to examination of the spine. Whatever may be the nervous disturbance, recovery is often complete, as the disease subsides and the inflammatory products around and about the nerves or cord undergo absorption. They add, however, to the gravity and anxiety of every case, and call for such treatment as shall best arrest the progress of the disease.

The treatment of Pott's disease is always a matter of considerable difficulty, especially amongst the poor, from the necessity of carrying it out for a very long time, for many months, or even years. Whatever be the special plan adopted, one principle, and one only, should underlie it, and that is to secure *rest* for the spinal column.

In the early stages of the malady, when its existence has been determined by the symptoms named, before deformity exists, whether the disease is slow or acute, or whatever its site, the child should be kept absolutely at rest in bed. He should lie on a good flat mattress, with the whole spine, from head to sacrum, as straight as possible; and if needful this end must be secured by the use of splints to the limbs, or other means, to prevent movement. The earlier the diagnosis is made, the greater likelihood

is there that simple rest in bed will stay the disease, and so obviate the permanent deformity which must in the end ensue. Doubly important, therefore, is early diagnosis. There is no credit in making a diagnosis when the hump is already there. When the disease has gone so far that the bodies are falling together, their friction against each other tends to set up irritation and aggravation of the disease, and it is then desirable to secure fixation of the spine in such a position of slight extension of the column that the apposition of inflamed parts of the bodies shall be prevented.

This may readily be accomplished by the application of a *Sayre's jacket* while the patient is in the prone position, or of a jacket made of poroplastic felt, resting satisfied with that amount of extension which may be gained by simple posture, rather than by forcible extension to run the risk of actually fracturing the spine. The jacket often gives immense relief; and having been applied, it must be a consideration in every case whether the child shall be allowed to run about or whether it shall still remain in bed. Moving about may sometimes be advantageous; in any case it will be less injurious when a jacket is on than when the spine has no support; but the wearing of a jacket should never be the excuse for letting a child run and play as if nothing were the matter with it. Rest in the recumbent posture should at any rate be enforced for many hours a day.

There is probably no kind of *abscess* in which the beneficial results of early opening under Listerian antiseptic precautions are now so manifest, as formerly there was none in which the results of opening, spontaneous or by the knife, were in the pre-aseptic days so often disastrous. The long sinuous cavity of an ilio-psoas abscess provided the very conditions for the origin of septicæmia after contamination with the

air, and the opening of a psoas abscess was frequently the beginning of a so-called "hectic fever," really a septicæmia, ending in death. Now all this is changed. In his description of the opening of a psoas abscess above Poupart's ligament, Mr. Cheyne says that "there are two reasons for choosing this situation. In the first place, the old rule that these abscesses must not be opened early is now done away with, and under truly aseptic treatment, as soon as fluctuation is detected, an operation is performed of a similar nature to that for tying the external iliac artery, and the abscess is opened after a careful dissection. The sooner the abscess is opened the better, for the abscess cavity is thus smaller than if the surgeon waits till the pus has burrowed its way into the thigh; and, further, so long as the pus is there it irritates by its tension, and thus keeps up the chronic inflammation in the spine. Another reason is, that it ought to be opened as far as possible from sources of putrefaction."* The same principle of treatment must be applied to lumbar abscesses; while for abscesses connected with the twelfth dorsal and lumbar vertebræ Mr. Treves has proposed to reach the seat of the disease, and drain the cavity by a carefully-planned dependent opening in the loin.† In one case thus treated by him a large sequestrum was removed. A dependent opening for the evacuation of ilio-psoas abscess has also been obtained by trephining the ilium.

Disease of the Cervical Spine.

It remains for us to consider those cases where Pott's disease, similar in all probability, both in cause and pathology, to that met with in the rest of the spine, involves vertebræ in the cervical region. The cervical vertebræ differ so much in shape

* "Antiseptic Treatment of Wounds," p. 84.
† Medico-Chir. Trans., vol. lxvii.

and size from those in other parts that disease in this region is more prone to light up in inflammatory mischief about the meninges or cord. In the region of the atlas and axis it is very prone also to involve the joints between these two bones, and less commonly those between the occiput and atlas. The transverse, odontoid and other ligaments also are frequently softened or destroyed, and slipping forward of the atlas upon the axis is the usual result, with narrowing of the spinal canal and pressure of the cord against the odontoid process. Sudden death is therefore always to be feared when there is disease in this region, and treatment must ensure the most perfect immobility of the head and neck.

The **symptoms** of cervical caries are of the same nature as when the disease is in other parts.

Pain is more common and often more definite than in Pott's disease in the dorsal region, and may definitely follow the course of one of the sensory branches of the upper cervical nerves, which issue from the spine in such close proximity to the disease. As Hilton pointed out, the pain is frequently unilateral. Severe neuralgic pain, therefore, increased by pressure on the head or neck, or by any sudden movement of either, in the course of the cervical nerves, the great and small occipital, the great auricular and superficialis colli, or the sternal, clavicular, and acromial nerves, associated with rigidity of any of the muscles of the neck, especially the trapezii, should never fail to raise the suspicion of vertebral disease.

"Rigidity of the trapezii," Owen says, "when associated with stiff neck, is almost pathognomonic of inflammation in the cervical spine;" and when to this sign is added "neuralgic headache," there ought to be little difficulty in arriving at an accurate diagnosis, and the error should be avoided of looking on the case as one merely of "rheumatism" or stiff

neck. The same kind of neuralgic pain may be felt in the periphery of branches of the brachial plexus when disease is in the lower cervical region.

Deformity is not so marked in the neck as elsewhere, because the smallness of the parts destroyed makes angular projection an improbable result. In atlo-axoid disease the head is poked forwards, from the slipping forward of the first upon the second vertebra. The chin points downwards, and perhaps one or more of the spinous processes become unduly prominent. Compensatory curves are established in other regions to remedy this position when the disease has been arrested and there is permanent rigidity.

Swelling makes its appearance pretty soon from inflammatory exudation into the soft tissues, and there may be distinct fluctuation and abscess in the suboccipital region. Oftener, however, the pus travels far from the original seat of the disease, and, guided by the fasciæ around the muscles, and by gravitation, may appear in the posterior triangle, in front of the trapezius, or near the posterior border of the sterno-mastoid muscle. When the disease is strictly confined to the anterior parts of the vertebra, abscess may point in the posterior wall of the pharynx, where it may even burst and cause death by suffocation. The same line of **treatment** must be followed in the case of cervical abscesses as in other regions; while the difficulty of emptying and draining a post-pharyngeal abscess antiseptically may be overcome successfully by burrowing down to it from an opening in the side of the neck behind the sterno-mastoid. Absolute rest is again essential in all these cases. In atlo-axoid disease the patient must lie perfectly flat upon his back, and, as recommended by Hilton, the neck must be supported by a small firm pad to fill up the suboccipital fossa, while the occiput itself rests on a cushion or circular pad. Tilting forward of the atlas is

thus prevented, and the cord is relieved from pressure. Immobility must be secured by sand-bags on each side of the head or neck, or by fixing the head with bandages. And thus the patient must lie, with head and neck immobile for, it may be, many months; and not until all active mischief has subsided and anchylosis has occurred should there be any experiments in moving the head. When disease involves the lower cervical vertebræ the head must be supported and the neck fixed by a cervical collar. The necessity for absolute rest in bed must be determined by the activity and extent of the disease.

Pott's disease in adults.—Pott's disease is most commonly met with in early life; but it may be seen in adults, and follow precisely the same course, with a tendency very often to be more rapid in progress than it is in children. In adults it may be due to syphilis, and in the cervical region may be set up by syphilitic ulceration in the posterior wall of the pharynx. Constitutional treatment must clearly be directed to this special malady, in addition to local measures for securing rest.

Spondylitis deformans is the name given to a disease which affects the vertebral column, and is the same, or of the same nature, as that termed "chronic rheumatic arthritis" when affecting other parts. As a consequence of absorption of the articular cartilages and of the intervertebral discs, and the development of osteophytic prominences from the edges of the vertebral bodies, and ossification of the ligaments, especially the anterior common ligament, the spine becomes bent and rigid, and a very characteristic deformity is the result.

Symptoms.—Cyphosis is produced, and as the disease frequently affects the whole or major part of the column, there is one long antero-posterior curve, the patient has a constant stoop, his stature is

diminished, there is complete rigidity of his spine, and his movements are awkward and constrained. In lesser grades of the disease the cervico-dorsal or the lumbo-dorsal regions may be alone affected, and the signs are less pronounced. With advance of the disease the spinal muscles waste, and the curvature becomes more prominent, the head is poked forwards, the shoulders appear unusually round, and the patient is obliged to support himself with a stick.

Spondylitis deformans, sometimes called "synostosis of vertebræ," is commonly a disease of later middle and advanced life, is seen more often in men than in women, and is, perhaps, determined to some extent by occupations which involve long stooping at work. It is generally associated with evidences of rheumatoid disease in other parts of the body. Rarely it is met with earlier in life, when in all probability the combined effects of heredity, and of those somewhat indefinite conditions, cold, exposure, lack of food, which may be supposed to excite and further the development of any inherited malady, have lighted up the disease. In such cases it may happen that every joint of the spinal column may become involved, and the term "intervertebral arthritis" may fitly be applied to them. The suffering may be extreme, and the tendency is to early death from exhaustion and pain. In the chronic cases of older people, however, there may be neither pain nor much obvious interference with the general health, and the patient may live for years.

No known *treatment* has any influence on this obscure and little understood disease. It seems probable that in some cases the disease has been started in connection with gonorrhœa, a sort of "gonorrhœal rheumatism;" but if on this point there be doubt, there is none as to its having become worse during an attack of specific urethritis. Much has yet to be done in elucidation of this strange malady.

X. INJURIES OF THE SPINE.

Herbert W. Page.

Contusions and contused wounds of the back do not differ in the main from the same kinds of injury in other parts. The thickness, however, of the skin of the back prevents it from giving way even after considerable violence, and extensive subcutaneous extravasation of blood (hæmatoma) may be met with, which undergoes absorption in the usual way. As the result of any severe injury of the kind, stiffness of the back is not improbable from damage to some of the spinal muscles.

The *treatment* of this condition will be considered when we come to speak of spinal sprains.

In cases of severe contusion in the lumbar region, even without external mark or laceration of skin, it may happen that hæmaturia soon shows itself after the accident, owing to damage to the kidney. The symptom is not by itself alarming, and it is very rare for hæmorrhage to be fatal from this cause. Nay, the tendency is rather for the bleeding to cease spontaneously in the course of a few days. (*See* Art. xii., vol. iii.)

Punctured or incised wounds of the back may cause grave injury. The horizontal direction of the spinous and transverse processes in the neck renders it by no means difficult for any long, sharp, narrow instrument to penetrate the spinal canal, and so wound the spinal membranes, wound or sever one or more of the spinal nerves, or even the spinal cord itself. The same calamity may also happen lower down.

The *diagnosis* of simple puncture of the spinal canal can only be a matter of certainty when there is escape of cerebro-spinal fluid, and by an accurate knowledge of the direction of the wound and the form of the weapon which inflicted it.

Symptoms.—Injury to spinal membranes alone in such a wound may cause no immediate symptoms, but there is great risk of acute inflammation or meningitis. The symptoms now are well marked and, in varying proportions, consist of pain and tenderness, spinal rigidity, and dread of being jarred or moved, pain or hyperæsthesia in the periphery of the nerves which have origin at the site of the inflammation, impairment of motion and sensation, rapidly passing, it may be, into complete paralysis in the parts below should the cord itself become involved in inflammation, a tendency to opisthotonos, high temperature, rapid wasting, vomiting, and general unrest.

The *prognosis* is extremely grave. Great also is the danger if the cord itself has been injured, a fact which may be told by the existence of paralysis, of interference with and perversion of motion or sensation, or of both combined, over a limited area, or universal in the parts below the seat of injury, according to the site and extent of the wound, changes in the reflexes, and alteration in temperature in peripheral parts: phenomena indicative of disturbance in the conducting paths and central functions of the cord. Even if the external wound and that of the spinal canal be closed, and meningitis has been escaped, complete recovery is in such cases rare, for union and repair of any wound in the cord are both uncertain and imperfect. Some paralysis is too likely to be permanent, and secondary degeneration in the cord may induce other and later symptoms of nervous disturbance.

Treatment.—The surgeon must make it his first care to ensure the perfect asepticity and early closure

of the wound, and the spine must be kept absolutely at rest. Meningitis is the immediate danger to be feared, and it may be well to begin at once with the administration of mercury or ergot, or of both combined, in the hope of controlling the tendency to inflammation in the meninges and cord.

Sprains of the back and spine are extremely common, and often troublesome. They do not differ, either in cause or pathology, from sprains elsewhere; but the fact that the spinal column consists of many separate bones connected together by an almost incalculable number of ligamentous and muscular fibres, many of them deeply seated, and that it has also in its constitution a large number of joints, renders the symptoms of vertebral sprains, and their consequences, prone to last longer, to cause more suffering, and to be more obscure than like injuries elsewhere.

The most flexible parts, the cervical, cervico-dorsal, and dorso-lumbar regions, are the most liable to sprain, the stretching, partial rupture, or laceration of muscular and ligamentous structures being frequently the result of violence, which has led to the spine being inordinately bent, or because they have given way in an unwonted muscular effort; as when a man, in lifting a heavy weight, ruptures some fibres of one or both of the erectors of his spine. There is, of course, an infinite variety in the degree of this form of spinal injury, and it is simply a question of degree whether the damage affects only extraspinal structures which hold the segments of the column together, or whether the more important intraspinal organs have been injured because of more complete separation of those segments as occurs in fracture-dislocation.

Symptoms.—Be the cause what it may, and in whatever region, the symptoms of spinal sprain are such as are seen after sprains of the limbs, viz. local

pain and local tenderness, and in some cases slight local swelling, with stiffness and rigidity of the affected part.

After bad lumbar sprain, which may be termed *traumatic lumbago*, it is not unusual, as in cases of simple lumbago from cold, for the patient to feel much difficulty in walking; and a state of pseudo-paralysis of the legs may be induced, simply from stiffness and incapacity of the spinal muscles, which no longer give natural support to the spine, or which cannot be called into action without pain. The patient complains, and may fully believe, that he cannot move his legs; but careful inquiry will elicit that he is really afraid to move them because of pain. Difficulty in defæcation and micturition, and inability to completely empty the bladder, or even retention of urine, may arise from the same muscular incapacity. The combination of such symptoms, spinal pain and stiffness, difficulty in walking, and interference with the natural acts of defæcation and micturition, may suggest very grave inferences that the injury has indeed been more serious than it really is, and has even involved the spinal cord.

An accurate *diagnosis* must be sought in the history of the injury, in the existence of local aching and stiffness, and in observing the time of onset of these seemingly paralytic symptoms. In cases of real intra-spinal injury, paralytic symptoms are much more likely to be found immediately after the accident, while after simple sprain they may be entirely absent until the stiffness and pain become pronounced, as they usually do in the course of a few days. Where certain diagnosis is impossible, it is better to err on the side of assuming central injury, than of failing to recognise it. For here arises a dilemma, that the later treatment of spinal sprain is that which we ought especially to avoid, were it known that there

was injury to the spinal membranes or the cord. This, unquestionably, is movement, systematically carried out so as to lessen the stiffness and its attendant pain.

Treatment.—As in the treatment of sprains elsewhere, so also is it in the case of the spine, *movement* must be begun as soon as by rest in bed and the application of warmth with hot flannels or linseed poultices, the pain has been allayed, the tendency to inflammation has been kept in bounds, and nature has set about the work of repair. No precise rules can be laid down as to the length of time during which rest must be enforced. The constipation may be relieved by aperients or simple enemata, and any difficulty with the bladder may be relieved by the use of a soft catheter scrupulously clean. These early troubles having been met, we must have the patient out of bed, so that by the movements of walking and gentle gymnastic exercise the stiffness and pain may be removed. Towards this end massage of the affected muscles may sometimes be of great service. The symptoms, aching and stiffness, are often, however, of long continuance, and it is frequently difficult to carry out the requisite treatment in consequence of the pain which movement entails. Movement and the application of heat may be beneficially combined by ironing the back with a hot iron, for the heat compels the patient to move, and so call fibres into action over which he has no voluntary control. The pain and stiffness are most liable to last for a long time in those who lead a sedentary life, a fact which shews the value of movement, and in those also who have a tendency to gout or rheumatism. In such cases, in addition to constitutional treatment, the occasional application of the combined faradic and galvanic currents to the affected muscles will sometimes give relief when other means have failed.

It is a question how far in some of these cases the continuance of the pain and stiffness, when definitely local and perhaps unilateral, may be due to a more direct involvement of, and effusion into, one or more of the spinal joints. In rare instances *suppuration* in a joint has followed severe spinal sprain, and it may be that simple effusion at times occurs and gives rise to the same sorts of symptoms as effusion in the joints of the limbs.

The spinal injuries of railway collisions are essentially of the same kind as those which have been already described, and are very common after such forms of accident, because the violence is exactly such as to cause undue bending of the spinal column, or strain of muscular fibres when the patient is unconsciously holding his body stiff, as an involuntary means of protecting himself from injury. This form of spinal injury is often more severe in what may be called slight collisions, for then it is that the patient is likely to be thrown to and fro several times in the carriage, a result which does not happen in the severest accidents, when all is over in some sudden crash, destructive to the carriages, and frequently to life and limb. The spinal sprains thus received are of every variety and degree, and cases are sometimes observed where the whole vertebral column seems to have been sprained, is painful and tender throughout its whole length, and the least movement is for a time well-nigh impossible. Then especially is it that the existence of pseudo-paralytic symptoms is likely to cause difficulty and trouble, for it rarely happens that spinal sprain is the sole injury sustained.

Symptoms.—As a consequence, to some extent, of the general violence, but more especially of the alarming circumstances of the accident, the patient is prone to suffer from a train of symptoms which have their beginning in undoubted collapse,

which do not, however, pass away like the usual symptoms of shock after other and commoner injuries, but may be protracted and little amenable to treatment. As the result of the shock, of shock which is largely if not entirely due to fright, there is developed a condition of general bodily and mental depression, a state of neurasthenia, or nerve weakness and exhaustion, which is not dependent on any known structural changes, and which may even arise in those who have met with no bodily injury at all.

This state of neurasthenia is characterised by various symptoms, of which derangements of the circulatory and vaso-motor systems are the most pronounced; and we meet with palpitation, alternate sensations of heat and cold, coldness of the extremities, sweating, diarrhœa, menorrhagia, and sometimes polyuria, together with great restlessness, sleeplessness, and nervousness, as marked, perhaps, in males as in females, loss of control over the emotions, a tendency to hysterical crying, asthenopia from weakness of accommodation, suppression of the catamenia, great languor, and early fatigue and exhaustion after any physical or mental work. The whole condition, which varies much in individual cases, may be summed up in the one word *neurasthenia*, which indicates that something has occurred to depress and lower the tone, vitality, and function of the whole nervous system, cerebral, spinal, and sympathetic.

The nervousness and depression may be extreme, despondency is a necessary part of the condition, and the patient is prone to give way to his feelings. In this state of neurasthenia it is that the pseudo-paralytic symptoms of spinal sprain are likely to be regarded as of more serious moment than they really are, and to suggest that there has been injury to some parts of the central nervous system. These cases of railway injury are likely to make large

calls on the good judgment and tact of the surgeon, for unfortunately the patient is subjected to influences which may seriously retard his progress towards recovery. Prospective compensation may tempt him to fraud and exaggeration, or may quite unconsciously prevent any voluntary effort being made to throw off the invalid state, which is the first necessary step in the return to work and a healthy mode of life. The worries of litigation are also seriously opposed to convalescence.

Treatment.—Rest both of body and mind is essential in the treatment of such cases, and it must be begun soon. Rest, good food, fresh air, must supply the chief means of treatment, for no drug has any special influence over this state of neurasthenia, unless, indeed, it be bromide of potassium, which, from its powerful depressant action, has a serious tendency to aggravate the symptoms which already exist, and to develop others of a like kind. In the great majority of cases recovery is complete, but in a small proportion of the severer cases the patients never seem to regain the same strength as they had before the accident, or do so only after a very long time.

Meningitis is a result to be feared in all cases of severe spinal sprain. There are two forms of inflammation of the spinal membranes, the *acute* and the *chronic*. To the former we have already referred in speaking of wounds of the spinal canal, from which this kind of meningitis usually starts. It may, however, arise when there has been no wound, either from septic poisoning, or some ill condition of the patient causing suppuration at the seat of injury, in connection, it may be, with some inflamed intervertebral joint. Suppuration spreads to the spinal canal, and lights up an *acute meningitis* which may speedily be fatal; and after death the spinal membranes are found bathed

in pus, and here and there, perhaps, the cord itself is softened and inflamed.

Subacute or chronic meningitis runs no such violent course, but is most insidious both in its origin and progress. Although extremely rare, it is nevertheless a result to be feared when the sprain has been severe, and especially in the flexible cervical spine. From laceration or rupture of an intervertebral ligament, one of the ligamenta subflava for example, there starts an inflammation which may spread inwards, until inflammatory lymph is poured out upon the spinal membranes, glueing them together, and by pressure implicating either the spinal nerves or the spinal cord. There is thus developed a *local* meningitis, which of itself causes, perhaps, no symptoms, and has never been suspected until some nervous structures have become involved, when the real mischief has then been done. Persistent local pain and local tenderness, increased by pressure or movement, more especially in the cervical region, should always arouse a suspicion of the existence of some deep-seated inflammatory mischief, and enjoin the necessity of absolute rest.

When the meningitis ("pachymeningitis," as it has been termed) has involved nervous elements, cord or nerve roots, other signs and symptoms help to make the diagnosis certain. We now find, in varying proportion and degree, interference with motion and sensation in the regions supplied by individual nerves, wasting of muscles, peripheral pains and other evidences of nerve disturbance.

Treatment is in such cases far from satisfactory. Counter-irritation should be used, either by repeated blisters to the spine, or by seton; and the persistent administration of mercury and iodide of potassium should not be withheld, even in cases where no syphilitic element is present.

Intraspinal hæmorrhage is a yet rarer result

than the foregoing of any violent twist or wrench of the spine, and is due to some vessel giving way within the spinal canal. The quantity of extravasated blood may be very large, and give rise to symptoms which are dependent on pressure upon the spinal cord. Paralysis may be complete of all the parts below the blood level, which, as it rises in the canal, may speedily cause death from interference with respiration. Intraspinal hæmorrhage may also result from falls on the buttock, or from severe blows on the spine; but from any cause it is extremely rare unless accompanied with other injuries to the spinal column, such as fracture-dislocation.

Symptoms.—It may be difficult to say whether the symptoms are really due to hæmorrhage or to some more immediate damage to the cord; but in the latter case the paraplegia is commonly instantaneous, while from hæmorrhage the symptoms may begin to show themselves only after lapse of time, or they may steadily increase as the blood is being poured out in the canal. Should the blood be small in quantity and low down in the canal, there may be few symptoms, and there is hope of its complete absorption and of ultimate recovery; but there is also a risk of inflammatory mischief, and the development of symptoms which are due either to the pressure of unabsorbed clot, or of subacute meningitis.

Treatment.—Ice must be applied to the spine, whilst the patient is kept at perfect rest on his face, and ergot or gallic acid should be administered. In the later stages we must follow the same line of treatment as in subacute meningitis. It is, however, but little amenable to treatment, both in its actual progress and in the after-consequences which may ensue.

A very rare result of violent and extreme bend of the spine is hæmorrhage into the substance of the cord

itself, with such symptoms as must necessarily follow its partial or complete destruction at the seat of lesion.

Fractures and Dislocations.

Injuries of this nature are most commonly caused by indirect violence, whereby the spinal column has been bent beyond the limits of its elasticity and the strength of the ligaments which hold its segments together. Parts of the spine, however, as of the vertebral arches, may be broken by the direct violence of a severe blow. Thus, one or more spinous processes may be detached, and the diagnosis is made by the mobility and crepitus which can be easily elicited. When the line of fracture is more deeply seated, and runs through the laminæ or pedicles, for instance, these usual signs may be more obscure. Any such deep-seated fracture entails the additional risk of being associated with intraspinal hæmorrhage, and of inflammation arising in close proximity to the spinal canal. The precaution, therefore, should never be neglected, after all severe blows on the spine itself, of acting as if fracture had unquestionably occurred, and keeping both the patient and the parts at absolute rest, so that repair may take place with a minimum of inflammatory action. Persistent pain in the region of one or more vertebræ increased by manipulation, and pain or hyperæsthesia in the periphery of one or more nerves emanating from the neighbourhood of the injury, should excite the suspicion of fracture. Should paraplegic or other symptoms of nerve disturbance be met with soon or late as the result of a severe blow on the spine, the symptoms are probably due to intraspinal hæmorrhage or to the pressure of inflammatory lymph. It is not common for the spinal cord itself to be affected in such accidents, although it has sometimes been found contused when the blow

has been caused by a bullet or shell striking the spine with the momentum of a great velocity.

Fracture-dislocation.—In fractures and dislocations from indirect violence the cord is almost invariably injured, crushed by the displaced vertebræ, or torn by the sudden and excessive stretching or bend. Amongst this class of injuries, the commonest by far are those in which fracture and dislocation are combined; but the exact nature of the lesion depends more upon the region in which it occurs than upon the mode of accident.

The smallness of the cervical vertebræ, their horizontal position, and the extreme flexibility of this region, render uncomplicated dislocation most frequent in the neck, although examples of it have been met with lower down.

Below the neck, however, the "broken back" is usually a "fracture-dislocation," from the fact that a greater violence is necessary to cause the injury, and that the vertebræ are not so readily separated from each other. Thus, of 394 cases collected by Ashhurst, 124 were pure dislocations, and of these 104 occurred in the cervical, 17 in the dorsal, and 3 in the lumbar region. These facts have an important bearing on prognosis and treatment, for in cases of pure dislocation the cord is somewhat less likely to be irreparably crushed, or, at any rate, lacerated, such injuries as it receives being, perhaps, from simple pressure alone. If, therefore, we can succeed in reducing the displacement in the rare cases where the displacement has not undergone spontaneous reduction, the cord may be thereby liberated, the paralysis from pressure on it may disappear, and the risk of destructive inflammation spreading in its substance may be lessened. And although the efforts to reduce a displacement lower than the neck, where probably fracture and dislocation are combined, are not so likely

to be successful, it may be well to make the effort, that the cord may have a better chance of repair, should it happen that it has not been crushed to pulp by the displaced vertebræ.

Signs.—In every region deformity is a sign of displacement; but in the neck, in addition to increased mobility, and the existence of a gap between spinous processes, there may be distinct projection in the pharynx, and the patient may experience difficulty in swallowing. Leaving, then, for a time, the nature of the injuries in special regions, and acknowledging that there may be infinite variety of lesion in different parts, there are certain characteristics more or less common to all cases where the "back" has been "broken" by indirect violence or inordinate bend. The intervertebral substance is more or less torn and separated from the bone, and the vertebra, which is the upper one at the site of dislocation, rides forward on that which is below it, and carries with it all the parts above, never being separated at the same time from both its fellows. Moreover, one or both of the articular processes may be dislocated, and a line of fracture may or may not run through any part of the vertebral arch. Ligaments are more or less injured, lacerated, or completely ruptured, and in the lower part of the column, in the lower dorsal region, for example, where fracture-dislocation is most common, it is not unusual to find that, in the extreme forward bending of the spine, a portion of the body of the vertebra immediately below the point of separation is

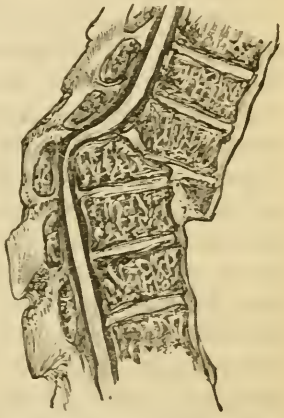

Fig. 93.—Fracture-Dislocation of the Spine.

broken off obliquely from above downwards and forwards (Fig. 93). The deformity thus induced may be permanent and irreducible; but in the upper parts of the spine, where the segments are small, it is by no means uncommon for the dislocated parts to return to their natural positions instantly after the accident. Whether the dislocation has been momentary or remains permanent, the cord is crushed at the moment of the accident.

Injury to the cord is, then, the source of chiefest danger in all cases of broken back, for inflammation is prone to spread from the seat of lesion, and gradually involve the centres of respiration, and cause death by asphyxia. The higher the lesion, therefore, the sooner is death imminent from spreading myelitis, and if we can liberate the cord by the reduction of displacement, we may perhaps remove one cause, at any rate, of continuing injury to it, and give thereby some better chance of life. Of no case, however, is it possible to think hopefully. We are in the presence of an injury which is almost inevitably fatal sooner or later, and the best we can do is, by good nursing, to make life comfortable and free from suffering as long as it lasts. The proposal made to trephine the spine, so as to relieve the cord from pressure, has met with no success, and has made no footing in surgery. Trephining the spine has no analogy whatever to trephining the skull.

Symptoms due to injury of the cord.—Paraplegia, or paralysis of motion and sensation, is commonly complete, and is of all parts below the seat of lesion. It may, however, be of lesser extent, and incomplete, and often motion is more affected than sensation. The limit of cutaneous insensibility is usually well defined, and may be mapped out with accurate precision, and the boundary between sensibility and insensibility may sometimes be

hyperæsthetic, a phenomenon probably due to the nerve trunks being involved in inflammation, and so irritated at the site of lesion. As myelitis spreads up the cord, so the line of insensibility gradually rises higher.

When there is no deformity the seat of lesion has to be determined by the level of the paralysis; and then it must be borne in mind that the nerve cords run with a gradually increasing obliquity downwards in the spinal canal; that in the cervical region, with the exception of the eighth, the nerves are named from the vertebra above which they issue, while below this region they are named from the vertebra below which they come out of the column. A nerve, in fact, comes off from the cord considerably higher than its name might imply. The cord, moreover, is most commonly injured at or about the lowest part of the displacement, that is, at the part where the upper or dislocated vertebra rides forward on the vertebra below it.

Speaking broadly, the higher the lesion the greater is the immediate danger, while above the origin of the phrenics, which issue above the fourth cervical vertebra, death is usually instantaneous unless the cord has not been entirely destroyed.

When the fracture-dislocation is below the second lumbar vertebra the paralysis may be very irregular in its distribution, or there may be none at all, because the cords of the cauda equina are less liable to injury than the spinal marrow itself. In any region the cord may be only partially crushed, and recovery is then more likely to ensue, with more or less of permanent paralysis.

In the upper dorsal region paralysis may seriously interfere with thoracic breathing, which, according to the level of the lesion, will be more and more embarrassed, until there is nothing

left but diaphragmatic respiration. The diagnosis of this kind of breathing is not difficult. The chest walls are not motionless, as might have been expected, but they sink from atmospheric pressure when the diaphragm descends, and rise somewhat suddenly again to their previous position when the diaphragm is once more relaxed. The chest cavity is therefore made small by collapse of the thoracic walls just when descent of the diaphragm is compelling the entry of air; extra work is thus thrown on the diaphragm, and the breathing becomes more and more laboured, for hypostatic congestion of the lungs soon arises. The alæ nasi work vigorously, the patient is obliged to breathe through his mouth, and his distress is added to by dryness of the throat and tongue.

Paralysis of the bladder is usually complete in all cases of fracture-dislocation when complete paraplegia indicates the severity of the cord lesion. Retention of urine is commonly the first symptom of it, and when the bladder has become full the urine runs over and dribbles away. In the course of a few days, perhaps, and more especially after injury to the cauda equina alone, the bladder may regain a certain amount of tone. The normal act of micturition is probably under the control of special centres in the cord, reaching from the level of the second to that of the fifth sacral nerves, some centres being connected with the sphincter vesicæ, others with the detrusor urinæ; and although in paralysis after injuries the action of both these muscles is commonly annihilated, it is conceivable that one may be affected while the other remains intact. Thus, for example, the bladder itself might be paralysed while the sphincter remained normal, and the reflex act whereby the sphincter relaxes in micturition being abolished, the bladder might fill until it burst.

It is often impossible to say what is the precise nature of the paralysis, and the state of the bladder must therefore from the first engage the surgeon's attention. A serious matter in these cases is the fact that the urine frequently becomes alkaline and purulent, and presents all those features which, together, are characteristic of *cystitis*. This change in the urine may appear in the course of a few days, and is probably due, in some measure, to the outbreak of lesions in some part of the urinary tract, kidney, ureter, or bladder, of the nature of those "trophic" lesions which have yet to be spoken of under the name of bed-sores, and to the urine being contaminated with the products of sloughing inflammation.

Cystitis and its symptoms may arise even when no catheter has been used, so that the view which attributes it to the introduction of septic matter into the bladder is not always tenable. In some cases it is doubtless due to the bladder being imperfectly emptied. It is a most difficult thing for some persons to empty their bladders, or even to micturate at all, in the recumbent posture, and cystitis of a mild degree may arise from this cause even in persons who have no real paralysis. Cystitis may become a source of danger by setting up or aggravating inflammation in the urinary passages, and in chronic cases may cause death by exhaustion or by the formation of "surgical kidney." The treatment does not differ from that which is suitable for cystitis in other cases, and no catheter should be used which is not scrupulously clean.

Paralysis of the bowel.—Closely allied in its physiological nature to the act of micturition is that of defæcation, which also may be variously affected after fracture-dislocations. The immediate effects depend, to a large extent, on the contents of the rectum

at the time of the accident. If full, involuntary evacuation will soon take place; while if empty, defæcation may not be until the rectum has become full. Hence the involuntary act of defæcation takes place only every now and then. Constipation is very common. Continuous "incontinence" is, indeed, very rare unless the motions are extremely loose. Occasional involuntary evacuation is the usual rule; but sometimes the patient acquires the power of telling when his rectum is becoming loaded, and the baneful consequences of involuntary and unexpected discharge may be thus avoided.

When the cord lesion is high up, additional distress may be caused by tympanitis, collection of flatus being favoured by arrest or diminution of the natural peristalsis of the intestines. This, also, not only adds to the constipation, but may even interfere with the already embarrassed respiration, and call for relief by the use of enemata containing some antispasmodic, such as asafœtida or turpentine. The tympanitis may also be relieved by the passage of a long tube into the sigmoid flexure. Aspiration of the gut in such cases is not devoid of risk.

Priapism, from vascular turgescence of the penis, is a common result of injuries of the cord, and is due, in all probability, either to passive distension of vessels from vaso-motor palsy, or to irritation of special centres, the exact seat of which has not been determined. The state of semi-erection is most marked during the few days which follow the accident, while at a later period it may only be induced by some local irritation, such as passing a catheter. Most commonly met with after cervical and dorsal injuries, it has in rare instances been seen after fracture-dislocation still lower down. Its import is uncertain, and it is neither influenced by nor demands treatment

Disturbances of temperature are sometimes very striking in cases of fracture-dislocation, especially when the cord injury is in the cervical region. When the fall incidental to collapse has passed away, there follows in some instances a very high range, the thermometer rising to 107°, 108°, or even 110° Fahr. The cause of this hyperpyrexia is by no means clear, but from recent physiological observations, which have been strikingly confirmed by the results of certain injuries or lesions, it seems probable that the heat production which ordinarily goes on in the body tissues is no longer restrained by supposed true calorific centres, having their seat in the cerebral cortex of each hemisphere near the fissure of Rolando, and having crossed action. A lesion may cut off this inhibitory action of one or both centres; and it is obvious that this result is most likely to ensue when the injury is high up, as in the cervical region when the cord is wholly crushed, and when a larger area of the thermo-genetic tissues is thus severed from the inhibitory centres in the brain (Hale White) Sometimes, also, in cases of cervical injury, the pulse becomes extremely slow, deliberate, and full. The precise seat of the lesions causing these phenomena has yet to be determined.

Of far greater importance is the occurrence of **bed-sores,** to the prevention of which the surgeon must devote his earliest care. In all probability there are two kinds of bed-sores. Some appear at points of pressure alone, such as the sacrum and great trochanters, and originate only after pressure has been long continued or unrelieved. They do not differ from pressure sores in other cases, but it is more difficult to prevent them, because the paralysed and helpless patient cannot gain relief by voluntary change of posture. The tendency to their

formation may, however, be largely diminished by placing the patient at the earliest moment on a water or spring bed; and by the use of ring cushions, stuffed with horse-hair or cotton wool, we may ensure that such pressure as is unavoidable may be widely diffused instead of bearing on one small point. The skin, moreover, may be protected with plaister, or hardened by bathing it with spirit lotion, and all contact with urine or fæces must be prevented. Bed-sores of the other variety run a more rapid and violent course, and cause extensive destruction of tissue. These also are found most commonly at sites of pressure, but not invariably so, and they may have a destructive rapidity which seems out of all proportion to any pressure which can have been exerted. Sometimes they appear within a day or two of the accident; and from all their characteristics it seems highly probable that they are really the result, directly or indirectly, of some "trophic" disturbance, either due to inflammation of the cord, or through the intermediate influence of a peripheral neuritis which has arisen as the result, in some as yet unexplained manner, of the myelitis. To such bed-sores the name "*decubitus acutus*" and "*decubitus ominosus*" has been given, and more recently that of "*neuropathic eschars.*" While ever of gravest import, it sometimes happens that the destructive process is arrested, the sloughs become detached, and healing may ensue. In both kinds of sores the detachment of slough may be hastened by linseed or charcoal poultices, and when granulations have been formed the ulcer may be dressed with stimulant ointment or lotion, pressure being as much as possible avoided.

Alteration in the reflexes is a common sequence of fracture-dislocation, and the phenomena vary according to the site of the cord lesion. When situated in the dorso-lumbar region, the knee jerk,

for example, may be abolished and may remain so; but it often happens in the course of a few days, as myelitis sets in, that the reflexes become exaggerated, and a sensory stimulus, such as tickling the feet, or the movement of the bed clothes, may, unknown to the patient, cause spasmodic movements of the legs, which are most distressing and interfere with perfect rest. The character of the reflexes, both superficial and deep, may give, in both recent and chronic cases, most valuable information as to the site and extent of the cord lesion. The reader must refer to special works on nerve diseases for fuller knowledge on this subject. The injuries of special regions now demand our consideration.

Fracture-dislocation in the cervical region.—Separations between occiput and atlas are most uncommon, for the range of movement between them is limited, and the ligaments are strong. The most frequent injury in this part, from falls upon the head whereby the upper spine is violently bent, is separation of the atlas and axis, the first vertebra riding forwards on the second, and causing instant death from crush of the cord against the odontoid process (Fig. 94). The odontoid is itself sometimes broken off, and one or both of the check or other ligaments give way; but notwithstanding that death is usually instantaneous, there have been cases where the odontoid has become anchylosed in a new position, and recovery has taken place with permanent narrowing of the spinal canal.

Separations between the second and third vertebræ are usually associated with fracture.

Below the third cervical we enter the region where pure dislocations are more common from falls upon the head and neck.

Symptoms. — The cord is usually crushed in

its entire thickness, and life is rarely prolonged for more than two or three days, thoracic respiration being annulled, and diaphragmatic alone left. The phrenics come out above the fourth vertebra, and may escape injury even when the separation is at this level; but myelitis will speedily put an end to the integrity of their centres. Below this point, as far as the second dorsal, it is necessary to remember the origin of the cords of the brachial plexus, and the distribution of its branches, in making a diagnosis as to the exact seat of lesion, and that the descending branches of the cervical plexus may allow of perfect cutaneous sensibility in parts much below the level of the destruction of the cord. In partial lesions, when the anterior cornua are alone involved, movements may be paralysed according to physiological rather than anatomical connections. Extension, for example, may be paralysed, while flexion remains intact, because the correlated muscles, which cause a particular action of a limb, are grouped together in the spinal ganglionic cells.

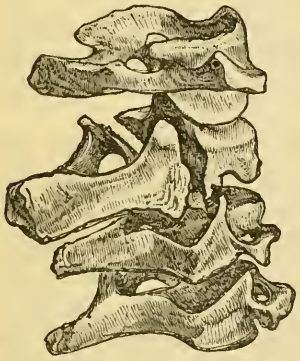

Fig. 94.—Fracture-Dislocation of the Upper Cervical Spine.

Injuries to the cord in the lower cervical and upper dorsal region may cause *paralytic myosis*, in which the pupils are unable to dilate because of palsy of the dilator fibres of the iris supplied by the sympathetic, which has an intimate connection with this, the "oculo-pupillary" region of the cord. The myosis is most marked when unilateral, but in any case it is necessary to examine the eyes both in light and shade in order to recognise it.

Fracture-dislocation in the dorsal and lumbar regions.—From the second dorsal vertebra downwards, fracture-dislocations are far more common than dislocations alone, and, as a rule, the cord is irreparably damaged. In fractures below the eleventh dorsal the prognosis is more favourable, for the size and strength of the vertebræ in this region render complete dislocation more difficult, and the cord escapes total destruction.

Below the second lumbar the cords of the cauda equina are less liable to injury than the spinal cord itself.

Paralysis may from the first be incomplete, and there may be considerable return of motion and sensation, and of control over bowel and bladder. Cystitis and bed-sores are the chief risks to which the patient is exposed. Deformity is likely to be permanent, and when repair is taking place the application of a Sayre's jacket may give comfort by ensuring rest and fixation of the spine.

Injury to the sacro-coccygeal joint.—The sacro-coccygeal joint may become the seat of disease from injury, and any movement of it, as in defæcation, or in excessive action of the gluteus maximus, which has attachment to the coccyx, may give rise to pain. There may also be local heat and swelling. These symptoms and signs are of importance in diagnosis, because "coccygodynia," or neuralgic pain, is a not uncommon affection, especially amongst neurotic women. Rest is essential in the one case; it probably has little influence in the other, and attention should be rather directed to the pelvic viscera, uterus, and ovaries.

Unilateral dislocations of the spine are not uncommon in the neck, from violent bend or even extreme rotation. Here two articular processes are separated from each other, and

the inferior comes to ride in front of the superior, the head is turned and fixed towards the opposite side, local deformity may be felt if the neck is thin, and either by some impairment of motion and sensation, or by pain and tingling in the periphery, there may be evidence that the nerve which issues from the spine at the site of injury is being irritated by stretching or pressure. Reduction should be effected at once by extension of the neck so as to disengage the processes, and turning the head into its right position. Rest must be enforced for some time afterwards, and the prognosis is favourable unless there be fracture also, or the cord has been itself damaged.

CONCUSSION OF THE SPINAL CORD.

This term ought to be restricted to those cases in which an injury has been inflicted on the cord from blows upon the spine, similar and analogous to the effects produced on the brain by blows on the skull. In the case of the head it is well recognised that severe concussion blows upon it may cause contusion of the brain substance both near the site of the blow and at opposite parts from *contre-coup*, and in addition certain effects which are commonly those of collapse from the shock or concussion of the whole brain mass. Although brain and spinal cord are merely different parts of one system, their physical surroundings are yet so different that that which is a common injury in the case of the brain is extremely rare in the case of the spinal cord. There are, indeed, very few cases on record in which it is possible to say that the cord has been locally injured, stunned, or contused by concussion only; and careful examination of many which have been so recorded shows that sufficient attention has not been paid to the effects of direct contusion from displaced vertebræ, of hæmorrhage around the

cord, or of hæmorrhage into and laceration of its substance from violent sudden bend.

Given, however, a case in which the cord has been locally concussed or contused, the resultant symptoms are the same as are met with from local injury due to other causes; and they would doubtless be the same if the injury merely consisted in local stunning, for a time, that is, until the effects of the concussion or stunning had passed away. Nevertheless, it is extremely doubtful whether this latter condition ever follows local injury.

Railway spine.—It has been thought by some that the severe nervous disturbances which are seen after railway collisions are due to concussion of the spinal cord, but there is no evidence that the spinal cord is any more affected than are other organs of the body by the severe shock of such accidents; and although it is conceivable that prolonged functional disturbance thus originated may end in structural degeneration, such a result is very very rare, and occurs perhaps in those only who, by various causes, are predisposed to the outbreak of nerve disease. It must not be forgotten that concussion of the brain is often caused in railway accidents, and many of the after-symptoms of neurasthenia are rather due thereto than to injury to other parts of the nervous system. It has indeed been suggested that the term "railway brain" is more appropriate than "railway spine."

Concussion injuries of the cord, much more analogous to concussion injuries of the brain, are sometimes met with in connection with gun-shot wound, where the great momentum of a bullet upon the spine may cause contusion of the cord without opening the spinal canal. The term also is applicable to cases where many minute lesions, giving rise to immediate paralytic symptoms, have been caused by a fall from a height flat upon the back.

XI. INJURIES AND DISEASES OF THE NECK.

Victor Horsley.

I. Wounds and Contusions of the Neck.

A. **Contusions.**—A blow directly on the neck will in all cases cause a certain amount of ecchymosis, *i.e.* extravasation of blood. So long as this is superficial to the deep fascia it is of no importance, provided the skin is unbroken. It frequently extends in the loose subcutaneous tissue almost to the middle line posteriorly, and in front may reach below the clavicles on to the chest. If, on the other hand, the extravasation is beneath the deep fascia in the loose connective tissue surrounding the large vessels and nerves, then it will, by pressing on the same, cause symptoms sometimes of an alarming character.

As for direct injury to the deep cervical structures from a blow, we may note an accident which is not an organic lesion, but a disturbance of function which may end fatally, namely, spasm of the glottis.

As a result of contusion the larynx may be fractured or the œsophagus ruptured. The arteries may be damaged so as to produce a traumatic aneurism, and injury of a vein may lead to the formation of a blood cyst. Injury of the sympathetic nerve, if sufficient only to irritate it, will cause dilatation of the pupil and protrusion of the eye-ball, while if it is paralysed then the pupil will be dilated, the eye-ball retracted, and the secretion of sweat on that side of the head and neck interfered with.

B. **Wounds.**—Simple uncomplicated wounds of the neck must be treated on general principles, and

may be expected to heal by the first intention if the parts are kept perfectly at rest. For this purpose the patient's head and neck should be fixed by being placed between sand-bags covered with a thin pillow, or a light splint of guttapercha may be fitted to the shoulders and nape of the neck, so that the head cannot turn. After ligature of large vessels this precaution should always be taken.

Wounds of special parts.—Punctured wounds, stabs, etc., in the *posterior triangle* may reach the subclavian vessels, the brachial and cervical plexuses, the spine and spinal cord.

If the large vessels are wounded, and the hæmorrhage temporarily arrested by plugging, pressure is to be made on the proximal side of the wound, which must then be laid freely open and the vessel tied with chromic catgut, and the wound dressed antiseptically. If one of the cervical nerves entering the brachial plexus, or one of the cords of the plexus, is divided by a cut, and no restoration of motor power has been attained at the end of five or six weeks, the wound must be reopened and the nerve sutured. If the spinal cord is reached by a knife, bayonet, etc., then the special symptoms of paralysis, etc., will denote the amount of injury (Art. x.), and treatment must be mainly directed to providing very free drainage of the wound, coupled with the liberal use of antiseptics. Wounds in the front of the neck and of the anterior triangle may be here considered together, although in some points, especially in their after effects, the regions differ. (*See* Cellulitis of the neck, page 477.)

Wounds of the *front of the neck* and of the *anterior triangle* may injure (1) the air passage; (2) the food passage; (3) the large vessels; (4) the large nerves. The ordinary cut throat of the suicide or homicide has always received special notice in surgical text-books,

but presents nothing peculiar in itself, unless it be endless variations in the extent of the lesion. Consequently, the symptoms attendant on injury of various important structures noted above will be described in detail, with their appropriate treatment, and as such symptoms are very distinct, any complicated case of cut throat is merely a combination of some of the above possible accidents. However, it cannot be too often insisted upon as a general fact, applicable to all cases, that the main importance of a wound in the neck does not lie in the immediate symptoms it presents, however urgent, but in the possibility of complications arising in the after-treatment; for since the former can be met by the ordinary rules of action in surgical emergency, the sequelæ (cellulitis, pneumonia, etc.) really determine the result of the case, and therefore the prognosis too.

1. *Wounds of the air passage.* — The pharynx may be opened by a horizontal cut passing above the hyoid bone through the base of the tongue, or below the hyoid bone in the thyro-hyoid space. Here, if the pharynx be extensively opened, the cut divides the epiglottis more or less completely according to the position it was in at the time. The divided epiglottis has sometimes caused asphyxia by dropping into the glottis, plugging it up, and exciting spasm. In either of these kinds of severe cut-throat about the hyoid bone, air and food will escape through the wound, and the tongue, when thus cut free from the hyoid bone, frequently presses backwards, and produces more or less suffocation; it must in such a case be drawn forward by a silk loop passed through it. After thorough washing out of the part with carbolic solution, the wound in the mucous membrane of the pharynx, where feasible, may be closed by sutures placed entirely in the submucous tissue, the angles of the skin wound apposed by a few horsehair sutures, and

free drainage with a large tube arranged in the middle third of the space. The wound heals always by granulation, as the movement of the parts prevents adequate rest for primary union, and it usually heals quickly if kept very clean by frequent irrigation. It must be wiped out, not syringed, if the glottis is exposed.

The larynx is usually opened by one or several transverse cuts about the lower part of the thyroid cartilage. While no special symptoms, beyond the usual escape of air, etc., directly accompanies this condition, it is especially liable to be followed by the very dangerous sequel of acute inflammatory œdema of the glottis. The glottis being cut into, usually above the vocal cords, it is exposed to the air, to irritation by blood, etc., and so acute œdema (in which the mucous membrane becomes extremely swollen by exudation into the loose submucous tissue) being excited, the lumen of the larynx is choked, and the patient rapidly becomes asphyxiated unless a tube is passed into the trachea. For this reason it is advisable to perform tracheotomy whenever the glottis is the seat of the wound, for the rapidity with which œdema glottidis sets in is so extreme as to sometimes kill the patient before the operation can be performed. At the moment when the wound is inflicted there is danger of asphyxia from blood running down between the vocal cords and filling the air passages; and a relatively small quantity of blood can thus produce fatal asphyxia, unless, of course, the patient is able to cough it up. In addition to œdema glottidis, the complication of emphysema may arise, in which condition the subcutaneous tissues of the neck become infiltrated with air and enormously swollen.

Finally, when the vocal cords are injured, or the cricoid cartilage is cut through, the voice is either completely abolished or very much weakened and hoarse.

If the trachea is only opened for a small distance, it will heal readily, as most tracheotomy wounds do. If, however, as rarely happens, it is very severely wounded (it has been seen completely cut across), it should be united with fine catgut sutures, the wound being kept freely open and frequently cleansed.

2. *Wounds of the food passage* are described in Art. v., vol. iii. Note may here be taken of the risk of septic infection with this complication. Where possible the mucous membrane of the alimentary canal should be closed by sutures.

3. There is no mystery about the symptoms of wound of one of the *large vessels.* If seen in time the bleeding point should be caught between the thumb and fore-finger of the left hand, one digit (preferably the thumb) being thrust to the bottom of the wound, the other being outside, pressing on the sterno-mastoid muscle. The bleeding being thus absolutely arrested for the moment, the wound should be enlarged up and down for a short distance, the fresh incision dividing the deep fascia. A finger of the right hand can now be brought to exert firm pressure directly on the trunk of the bleeding vessel, the wound in which can then be exposed by removing the left hand. It can then be completely closed by catch forceps. If the original wound gape very widely there will be no necessity to enlarge it, but no time is to be wasted in trying to compress the vessels through the intact structures of the neck. The wound in the vessel, now under perfect control, is to be permanently closed by ligature of the trunk above and below it. The wound is then to be disinfected and dressed.

4. Injury of the *large nerves* has already been alluded to.

In concluding the subject of wounds of the neck,

attention is again drawn to the fact that the majority of cases end fatally because, the wound decomposing, the foul discharge either sets up cellulitis, which spreads down into the mediastinum, or it enters the trachea and sets up septic pneumonia. Every care, therefore, is to be exerted towards thorough cleansing and disinfection of the wound.

II. Cellulitis of the Neck.

To grasp fully the conditions under which the loose connective tissues of the neck become the seat of cellulitis the arrangement of the cervical fasciæ must be borne in mind. **Cellulitis** may be started in any one of the regions of the neck occupied by connective tissue, by several causes, the commonest of which is inflammation of a gland, almost invariably a lymph gland, and more rarely the salivary glands. The lymph glands are liable, of course, to become inflamed by absorption of septic matter from a sore inside the mouth and pharynx, or elsewhere, especially in some acute specific fevers, *e.g.* scarlet fever, diphtheria, when the swelling of the neck receives the title of scarlatinal angina, cynanche maligna, etc., the name simply signifying that the connective tissue around the glands is in a state of acute phlegmonous inflammation.

Next to acute inflammation of the glands as a cause of cervical cellulitis, comes chronic adenitis, which is usually of tubercular origin, then wounds and injuries of the soft parts of the neck, alveolar abscess from carious teeth, and, finally, specific poisons, which produce the particular form of cervical cellulitis known as angina Ludovici (or Ludovigii), and the rare parasitic disease known as actinomycosis.

Cervical cellulitis presents itself in various degrees of severity, as cellulitis does everywhere. Thus we may have a simple but acutely developed œdema (acute

inflammation) of the connective tissue spaces as occurs sometimes in diphtheria. Or this may be phlegmonous. as in many cases of septic poisoning and scarlet fever, the centre of the phlegmonous mass softening down into an acute abscess. Further than this, the inflammation may be of so virulent a type that the result is gangrenous destruction of the tissues, producing sloughs bathed in a horribly fœtid ichorous fluid.

As the best example of this latter condition may be detailed the affection known as *angina Ludovici*, or submaxillary cellulitis or angina. The general causes which excite cervical cellulitis have just been mentioned, but it will easily be understood that the condition of submaxillary cellulitis is most usually started by a local spreading inflammation from an abscess round a carious tooth, or from septic inflammation of the submaxillary gland.

Angina Ludovici begins like an acute specific fever, and when not treated runs a very rapid course, ending fatally, sometimes in from five to nine days. It begins with pyrexia, the temperature rising rapidly to 103°, 104°, ushered in by a rigor, accompanied by headache, depression, and loss of appetite. When these symptoms are well declared, there then begins a swelling under the jaw, which is simply due to œdema of the connective tissue. The swelling forces the tongue upwards and backwards so as to form a large unwieldy mass in the mouth. This causes some pain in swallowing, and interferes with the free movement of the jaw and with speech. Frequently there is comparatively little pain in this affection ; but sometimes, if the swelling is developed very rapidly, the pain is severe, until the limiting fascia gives way and allows the pus to infiltrate the surrounding tissues, when the patient experiences considerable relief. If the swelling is incised at this time it will

be found to be composed of sloughy, but solid, connective tissue, infiltrated with foul greyish-brown seropus. The muscles become infiltrated secondarily, and the cellulitis may spread into the anterior mediastinum and even reach the pericardium, the patient dying of exhaustion and septicæmia if not relieved.

Treatment.—In all cases an incision, from 1 inch to $1\frac{1}{2}$ inches long is to be made through the skin and superficial fat, any vein divided being picked up with catch forceps. If the cellulitis is clearly defined and localised to one or the other spaces of loose cellular tissue in the neck, then it clearly must be under the deep fascia, which is therefore to be divided to the same extent as the skin. A certain amount of serous œdema fluid will ooze into the wound from the cut tissues. A steel director is now to be thrust carefully towards the centre of the swelling, and if foul ichorous matter flow along the groove of the director, a pair of dressing forceps is to be thrust (closed) along the groove to the centre of the abscess, and then withdrawn with the blades moderately separated so as to dilate the opening. Finally a large drainage tube should be inserted, and the whole

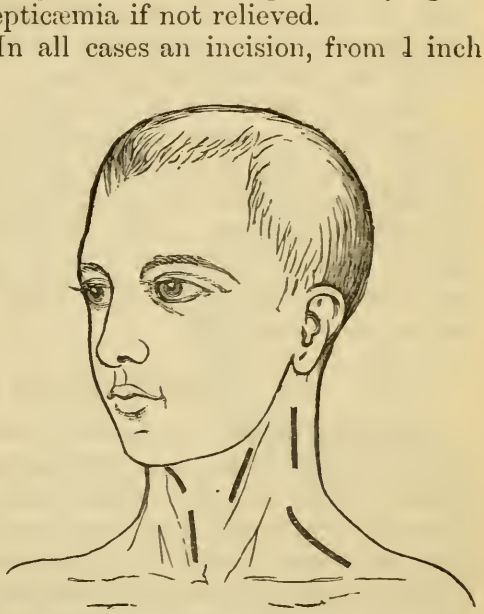

Fig. 95.—Incisions for Cellulitis of the Neck.

syringed out with warm carbolic acid solution. The neck should then be wrapped in hot fomentations of boracic lint.

The line of incision varies according to the space to be opened (Fig. 95). Thus, in the posterior triangle the cuts should be made parallel to the main vessels and nerves, taking care at the fore part not to wound the external jugular vein.

To open the spaces in front of the neck in angina Ludovici, the incision must always be made in the middle line, and if necessary a further one may be carried through the centre of the swelling, but this is rarely necessary. The connective tissue space around the carotid, etc., is to be opened as in the operation for ligature of that vessel, namely, parallel to the sterno-mastoid.

III. Tumours of the Neck.

Tumours of the neck include among their varieties several kinds which are peculiar to the region involved, these mostly being congenital in origin. Viewed as a whole they may very justly be divided into two main classes, viz. cystic and solid tumours. Cysts are usually arranged according to their contents, but for clinical purposes are best grouped in the anatomical order of the parts they arise from, and the same method will be employed in treating of the solid tumours.

A. Cystic Tumours.

1. **Cystic tumours arising from persistence of embryonic structures.**—The fissures in the neck, known as visceral clefts in the embryo, sometimes do not close, or only partially, *i.e.* at both ends and not in the middle, or at one end only. If the first imperfection exists, there may be found a prolongation of the angle of the mouth almost to the

ear, while at three points between the lower border of the jaw and the thorax it may present itself as a sinus-like cavity, running upwards and backwards from the front of the neck, sometimes only just admitting a probe, and always secreting a little thin mucous fluid. If the ends of such a "*congenital fistula*" are closed and the centre patent, then there develops a congenital cystic tumour, which may reach a large size and extend deeply (sometimes to the spine), so as to form important connections with the large vessels and nerves. These cysts form rounded, painless swellings, with exceedingly thin walls, and the skin over them non-adherent (Fig. 96). They usually contain a serous fluid, and therefore come under the general appellation of "hydrocele colli," but in some rare instances they are lined by one or more layers of epithelial cells, and contain a fatty material. If it should prove impossible to extirpate these cysts (after repeated aspiration has been tried), they should be injected with iodine or carbolic acid.

Fig. 96.—Large Congenital Hydrocele of the Neck.

The other common class of congenital cystic tumours are often called *dermoid*, but it must not be supposed that they always contain examples of all dermal appendages. These dermoid cysts usually are found in the middle line, where the somatic plates fuse together, and they arise no doubt from small masses of included epiblast. As may readily be imagined, they are also found in the sites of the visceral

clefts, but this position is rarer. The commonest seat is between the genio-hyoid muscles, where the tumour presents itself as a rounded swelling in the middle line, just above the hyoid bone. It pushes up the floor of the mouth and the tongue so as to project considerably beneath the buccal mucous membrane. These cysts, when they occur on the side of the neck, often form dangerous adhesions to the large vessels. Like the "hydrocele" cysts, these have very thin walls, but unlike them, the dermoid contents always contain a large quantity of yellowish-white fatty débris (cholesterine, etc.), with epithelial cells. More rarely hair, sebaceous matter, and teeth have been found in them. They must be extirpated with special attention to surrounding structures.

2. **Cystic tumours arising from the air and food passages.**

(*a*) Cysts containing air may arise in the neck from either the apices of the lungs projecting up under the sterno-mastoid, or from the side (usually) of the trachea (*tracheocele*). In the first case the cyst is an example of hernia of the lung (Art. I., vol. iii). In the second case, as the result of maldevelopment, the parts are not united in the middle line, so that a tracheal fistula is left; or one or more rings are wanting so as to render a hernia of the mucous membrane of the trachea possible when powerful expiratory effects are made, especially if the glottis be closed.

(*b*) The bursa between the hyoid bone and the thyroid cartilage may enlarge and become distended with fluid. It should, if acutely inflamed, be treated with leeches and hot fomentations. It may require aspiration, but I have seen the fluid absorbed in about a month in the case of a young man who refused all treatment. Aspiration is always of service.

(*c*) Cystic tumours may originate in the mucous glands of both trachea and œsophagus; the secretion being pent up so as to form retention cysts.

3. **Cysts arising from the blood-vessels.**

(*a*) The commonest blood cystic tumour in the neck is an aneurism (Art. xxvii., vol. i.).

(*b*) The next commonest, perhaps, is a simple cyst containing blood; the cyst being developed in connection with a vein or in an enlarged venous plexus. Another variety of cyst containing blood, more or less altered, however, is the so-called hæmorrhagic cyst, which condition results from rupture of some small vein or veins leading to the formation of a cystic cavity. Aspiration of this kind of cyst sometimes draws off blood so altered as to present a chocolate-like appearance.

(*c*) The third kind of blood cystic tumour is venous angioma, which develops in the neighbourhood of the vessels, usually in the posterior triangle. Beyond being extremely rare, it does not differ from ordinary venous angioma.

The treatment of blood cysts, omitting aneurism, depends on the nature of the cyst. If the latter is in connection with a large vein and is of moderate size, it is to be exposed, and the pedicle or the feeding vessel ligatured. If this is impossible it must be treated like an aneurism, viz. by electrolysis, etc. A hæmorrhagic cyst requires dissecting out where possible; if not, it must be scraped and drained. Venous angioma in the neck is always best treated by frequent puncture with the actual cautery at a dull red heat.

4. **Cysts arising from lymph vessels.**—Lymph cysts containing a thin serous fluid are probably more common than is generally believed. From their watery contents and the deformity produced they have been named "hygroma colli." They

are divisible into two classes, congenital and acquired.

Congenital hygroma is a very grave affection, the exact origin of which is not very clear. A child is born with a sero-cystic tumour usually over the carotid, the growth steadily increasing and causing death by pressure on the œsophagus, trachea, and blood-vessels. If punctured, it is found that the cyst is composed of loculi communicating with one another, and the walls of each firmly adherent to the large vessels and nerves. The treatment should consist in incision and antiseptic drainage.

In the adult a lymphatic cyst (acquired hygroma) in the neck is usually a single cavity formed by a fairly thick-walled sac, which is lined by lymphatic endothelium, so that there is little doubt of the nature of the tumour. It should be excised.

5. **Simple sebaceous (atheromatous) cysts of the neck** are not uncommon, and require no further notice here.

6. **Hydatid cysts of the neck.**—Very rarely, *i.e.* in 0·5 per cent. of all cases of hydatid disease, has the echinococcus been found in cysts of the neck. Treatment should be by incision and drainage.

Little has been said of the differential diagnosis between the various cysts described above, because the diagnosis between the different kinds is rendered sufficiently obvious by the description of each; but it is important to point out that they may be confounded with soft solid tumours, *e.g.* lipoma, and with abscesses (especially if chronic). In most cases aspiration with an exploratory syringe is harmless if performed antiseptically, and with due caution, while it frequently definitely decides the diagnosis.

B. Solid Tumours in the Neck.

The following description of the solid tumours is arranged according to the tissues they begin in.

1. **Tumours growing from the skin and connective tissues.**—The skin itself is occasionally the seat of nævi, warts, and epithelioma, the latter occurring especially in old cicatrices. These require no special notice. The subcutaneous tissue is very frequently the seat of one of the simple growths, *e.g.* fibroma and lipoma, which are most common in the posterior triangle. More rarely enchondroma and osteoma have been found springing from the remnants of the visceral arches or so-called cervical ribs. Primary sarcoma has been described growing in the connective tissue, especially in the anterior triangle. Special difficulties in diagnosis can only arise when these tumours are soft and growing deeply in fat subjects.

2. **Tumours of the muscles.**—These are very rare. There is, however, a definite tumour peculiar to the cervical muscles, especially to the sterno-mastoid, and occurring in new-born children-which must be noticed here. In breech presenta, tions, and in children the subjects of congenital syphilis, there is often noticed after birth a steadily increasing swelling about the middle of the sterno-mastoid muscle, which at the end of a month may interfere with swallowing, etc. It is clearly a syphilitic formation at a point damaged by rupture at birth, and is best treated with mercury and external anti-inflammatory remedies.

3. **Tumours of the lymph glands.**—These glands give rise to by far the largest number of tumours in the neck, so that it is worth while to digress for a moment to recall to mind their normal position. Besides the glandulæ concatenatæ lying

along the posterior border of the sterno-mastoid muscle, the following are constant sites for lymphatic glands, viz. over the carotid just at its bifurcation; a few smaller ones being arranged along the carotid sheath upwards and downwards from this point; over the submaxillary gland just below the body of the jaw; between the genio-hyoid muscles; over the parotid gland in front of the tragus of the pinna, and, occasionally, beneath the parotid. Lymph glands may give rise to tumours under the following conditions:

Simple hypertrophy sometimes wrongly described as lymphadenoma. The glands simply increase in size and density, the skin is freely movable over them and not reddened; the swelling is painless, as a rule, and non-adherent to surrounding structures. In true lymphadenoma the cervical glands partake of the general numerical enlargement, sometimes forming enormous collar-like masses on the sides of the neck. In these cases the glands are often so adherent to one another as to form, practically, a confluent mass. Simple enlargement occurs in young individuals placed under bad hygienic conditions, or over-worked, etc. The treatment consists in local counter-irritation by iodine, interstitial injection of the same, and general constitutional treatment. And if all these means fail, excision of the mass should be performed. (*See* Art. XXVIII., vol. i.)

Strumous disease.—Chronic inflammatory changes, in which caseation occurs early, is found in the cervical glands both in children and adults. The condition is described in Art. XIX., vol. i., to which reference is directed.

Chronic inflammatory and syphilitic enlargement.—These require only to be mentioned as causes of tumour in this region, reference for further detail being made to Art. XXII., vol. i.

Primary new growths. — The commonest new growth commencing in the lymph glands is sarcoma. It may be spindle-celled or round-celled, usually the latter, which is consequently termed lympho-sarcoma. This is excessively malignant, grows with great rapidity, and involves surrounding structures. Scattered glands may be attacked simultaneously. Early excision is the only, but not a promising, treatment.

Secondary new growths. — Cancer and round-celled sarcoma usually involve the lymph glands secondarily. Cancer, especially epithelioma, invades the glands nearest the original tumour. The enlargement of the gland is usually irregular, painful, and hard. It soon becomes very adherent on the outside to surrounding structures, while it degenerates in the centre so as to form a cavity filled with pultaceous débris. Early excision is the only treatment.

IV. Affections of the Salivary Glands.

A. **Simple inflammation of the parotid.**— The parotid gland inflames rarely from direct primary causes, but very frequently as a symptom of some acute specific disease. It is so common a feature of mumps as to almost render the terms parotitis and mumps synonymous. It also occurs frequently in pyæmia, and more rarely in scarlet fever, typhus, and small-pox. Acute adenitis of the submaxillary gland is as rare as that of the parotid is common. Parotitis usually presents itself as congestion and œdema of the gland, the acute swelling being painful, and causing movement of the jaw to be very limited. The incubation period of mumps is about three weeks, and after the swelling has developed, and is disappearing in one gland, the opposite one becomes affected.

Suppurative parotitis only occurs in very debilitated subjects, and in pyæmia. In the latter affection

it is heralded by a severe rigor, and is usually found to form a localised swelling, although the phlegmonous infiltration around spreads through the whole gland. Early antiseptic incision is the only treatment, coupled with the general treatment of pyæmia.

Gangrenous parotitis is a very rare affection, in which the inflammation terminates in sloughing of the superjacent skin, with subsequent destruction of the proper gland tissue. Treatment consists in free incision and the application of strong disinfectant solutions.

B. **Cystic tumours of the parotid.**—Occasionally the main duct of the gland becomes plugged by a calculus, so that the part behind the obstruction and the gland itself are distended to form a retention cyst. This condition is, however, rare in the parotid. In the sublingual region, salivary retention cysts are more common. Very rarely true cysts (probably arising from the blocking of a secondary duct) have been met with.

C. **Solid tumours; adenoma.**—Simple tumours in the salivary gland, composed of one tissue only, are very exceptional; in almost every case the growth is compound. Growths are common in the parotid, but rare in the submaxillary and sublingual glands. The ordinary non-malignant "parotid tumour" of the older writers is now known to be a fibro-adenoma. The adenomatous tissue is simply a copy of the original gland tissue, the lumen of the acini, however, being filled up with cells. Owing to changes in the fibrous stroma of the tumour, it is frequently more correctly termed myxo-adenoma, and from the not infrequent development of cartilage therein, is termed a myxo-chondro-fibro adenoma.

These simple parotid tumours grow very slowly, distending and usually rupturing the original capsule

of the gland, but forming a new capsule out of the surrounding connective tissue. While growing in the gland they can often be shelled out of this false capsule without wounding the healthy gland tissue. The skin, too, is usually freely movable over the mass. Occasionally the socia parotidis is affected alone.

The most important points to be borne in mind in connection with parotid tumours are (*a*) the facial nerve, and (*b*) the vascular supply.

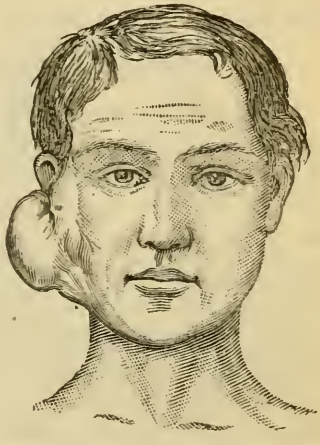

Fig. 97.—Adenoma of the Parotid Gland.

(*a*) The facial nerve running through the lower end of the parotid is liable to the paralysing effects of pressure from a new growth of the kind indicated. But it is more liable to be injured in removing the tumour, and the possibility of this accident (sometimes *a necessity*) should be explained beforehand to the patient. (*b*) As regards the blood supply, it is also to be remembered that the external carotid artery passes through the deep portion of the gland, but no notice need be taken of hæmorrhage when it is a question of thoroughly removing a growth, all vessels being secured with forceps as they bleed. The internal maxillary artery, will be found to bleed from both ends so as to require a double ligature.

D. **Adeno-sarcoma** is a growth which affects the submaxillary gland nearly as often as the parotid; it forms a steadily growing tumour (the rate of growth increasing with each recurrence) which becomes adherent to neighbouring structures, and invades muscles

and fasciæ. By pressure on the branches of the fifth nerve it gives rise to excruciating pain, and penetrates deeply between the jaw and the base of the skull. It sometimes affects the glands secondarily. Free excision must be performed.

E. **Carcinoma of the salivary glands** is very rare; scirrhus has been described as most common. An attempt to remove the whole mass may be made if the disease be not too far advanced.

V. Diseases of the Thyroid Body.

Up till quite recently an account of the diseases of the thyroid body has been confined to description of goitre and its treatment. There seems good reason now to believe that the thyroid gland may undergo active atrophic changes, accompanied by overgrowth of its stroma, so as to produce the fatal disease called myxœdema; and, moreover, that the condition known as cretinism results from non-development of the gland, and consequently loss of its function. A similar parallel is to be found in the case of Addison's disease, which there is very little reason to doubt is simply due to a loss of the function of the suprarenal bodies. Both in cretinism and in myxœdema the thyroid gland is either atrophied, or the seat of fibro-atrophic disease. The probable function of the thyroid gland, as established by experiments and clinical observation, concerns, in the first place, the control of the mucinoid substances in the tissues of the body, and albuminoid metabolism to some extent; and, in the second place, hæmapoiesis, *i.e.* manufacture of blood corpuscles.

1. **Atrophy of the thyroid gland** is followed by the disease called *myxœdema*, in which the patient becomes lethargic, the subcutaneous tissues swell from an accumulation of mucus, and produce an appearance like œdema, save that the swelling is resistent (the eyelids and lips especially being extremely puffy). The

blood becomes very anæmic, there being a loss of red corpuscles and an increase of leucocytes. The superficial vessels of the skin are dilated on the cheeks, etc.; and the hair, after getting very thin and fine, falls out rapidly. The speech becomes thick and slow, and the mental obfuscation increases until the patient gradually becomes almost imbecile. The temperature is almost always subnormal, and the urine free from albumin, except just towards the end. The general appearances are well seen in Fig. 98. This condition has been described at some length, for since I have produced exactly the same disease in monkeys by simply removing the thyroid gland, it is now possible to explain the results obtained by Kocher and others in extirpating goitres. At the same time there is proof that myxœdema is the result of atrophy of the thyroid body. Some hold to the hypothesis that myxœdema is in some way or other an affection of the sympathetic nerve, but on careful examination no primary changes have ever been found in the sympathetic.

Fig. 98.—Myxœdema.

2. **Tumours of the thyroid; goitre or bronchocele.**—Goitres are usually divided into two classes, simple and exophthalmic. They will here be grouped under the headings of congestive and neoplastic.

A. **Congestive goitres.**—(*a*) The thyroid body normally swells by congestion in the female under the influence of sexual excitement and pregnancy, also sometimes during menstruation. (*b*) It may remain swollen and pulsating strongly, so as receive the name of vascular or pulsating bronchocele. Finally we may have to deal with the very serious condition known as exophthalmic goitre.

(*c*) *Exophthalmic goitre.* — This is a variety of goitre which has obtained special distinction owing to the number and prominence of the symptoms. In a patient suffering from this condition the thyroid gland is swollen, often tender, and pulsating, while the eyes bulge out of the orbits, probably from vascular dilatation in the loose tissue of those cavities. The protrusion of the eyes (exophthalmos) may be so great as to cause conjunctivitis and ulceration of the cornea from exposure. The patient is at the same time very anæmic and weak. The pulse is full and soft, and an anæmic murmur is often to be heard at the base of the heart. There is usually amenorrhœa, loss of appetite, and prostration. The condition may end fatally; or after lasting, as described, for a few months, gradually vanish. Treatment is unsatisfactory since the causation of the primary congestion in the thyroid gland is unknown. Iron, electricity, etc., should be tried.

B. **Neoplastic goitres.**—(*a*) The thyroid body may undergo *simple hypertrophy*. This sometimes follows simple congestive goitre. The enlargement of the gland is both in the stroma and proper gland tissue, so that it is fibro-adenomatous. Sometimes this hypertrophy, which usually affects one lobe only, causes very severe symptoms, *e.g.* breathlessness on exertion, faintness and giddiness, trembling and weakness in the limbs; but as a rule, if actively treated, it gradually disappears. The mass should be

painted with iodine, or an ointment of oleate of mercury (2 per cent.) and morphia (5 per cent.) be rubbed into the skin covering it. At the same time quinine and iron should be administered in full doses.

(*b*) *Fibrous goitre* is the name frequently given to the mass when the stroma grows at the expense of the proper gland tissue. It is a convenient term if it is understood that the tumour is really a large fibro-adenoma, and that it may be very soft and vascular (then of rapid growth), or it may be chronic and of dense structure. As with simple hypertrophy, this disease usually affects one lobe (more commonly the right), and according to the rapidity of growth produces more symptoms (Fig. 99). It gradually forces the trachea to the opposite side, flattening it so as to diminish its calibre ; growing backwards it pushes the carotid artery and jugular vein with the vagus nerve even into the posterior triangle. It stretches the above-mentioned structures, which usually become adherent to the capsule of the tumour. The tumour itself is situated beneath the deep fascia, and is surrounded by the loose tissue of the neck. Owing to its relations to the trachea (the isthmus being fixed to that tube by a firm layer of fascia), the tumour rises and falls with every effort at swallowing which the patient makes, a diagnostic sign of the greatest value. The vessels are often enormously

Fig. 99.—Fibrous Goitre.

enlarged, the thyroid arteries being sometimes one-third of an inch in diameter.

(*c*) *Cystic goitre.* — Before describing the treatment of fibrous goitre, it will be best to mention the cystic condition. Cystic goitre is simply fibro-adenomatous goitre, in which large cysts appear derived from the acini of the gland. The contents of these cysts are usually fluid, serous, bloody, or colloidal. They sometimes attain a large size, making up most of the mass of the tumour. The walls of the cysts are frequently extremely vascular, and in long-standing cases calcified.

Treatment of goitre.—If slow growing, inunction of mercury or iodine may be tried first. If these fail and the mass is cystic, then injection of iodine or of iodide of potassium or perchloride of iron into the substance of the growth or into a cyst may be employed. Great care must be taken to avoid puncturing a vein, as the direct injection of most of the above fluids into the blood stream is a fatal accident. After the canula is inserted, a delay should be made before injecting, to see if a stream of blood flows out indicating wound of a vessel. If the tumour is very soft and rapidly growing, injection sometimes produces violent inflammatory mischief, leading to cellulitis of the neck and abscess. Removal of the whole goitre is a successful operation when performed antiseptically, but should be confined to one lobe only. Kocher showed that complete removal of both lobes was followed by myxœdema. This he thought was a result of chronic asphyxia or injury of the sympathetic; but my experiments above referred to show that it is due to loss of the function of the gland. Moreover, the removal of one lobe causes atrophy of a tumour in the other, and excision of the isthmus relieves pressure symptoms, and also causes atrophy of the growth, so that these operations are alone justifiable.

VI. Affections of the Larynx and Trachea.

Fractures and scalds of the larynx and trachea.—Contusions and wounds of the larynx and trachea have already been referred to. There remain then fractures and scalds of those parts for consideration. As *œdema glottidis* plays a most important part in deciding the nature and treatment of these cases, a few words may be added to what has already been said at page 475. In the first place it must be noted that œdema of the glottis may come on "idiopathically," *i.e.* in some cases of Bright's disease. Occurring in middle-aged men, it is not very uncommon to find that the patient is seized with rapidly increasing difficulty of breathing, requiring to be sat up in bed, using all the extra muscles of respiration, and becoming cyanotic. In these cases the mucous membrane of the pharynx and larynx (especially the loose aryteno-epiglottic folds) becomes enormously swollen from rapid transudation of fluid into the submucous tissue, and it is this swelling which blocks up the entrance to the glottis, and so causes dyspnœa. If met with early, this so-called idiopathic œdema (exactly the same thing is seen in wasp or bee stings of the back of the throat) can sometimes be got rid of by causing the patient to inhale steam as hot as it can be borne, but it often requires operative interference. Scarification of the aryepiglottic folds, performed by scoring the mucous membrane with a curved probe-pointed bistoury, is sometimes followed by complete relief as the fluid and blood flow out of the cuts. As a rule, however, laryngotomy must be performed; without an anæsthetic (or with preliminary freezing of the skin) for these cases which are specially liable to fatal syncope which might be induced by chloroform.

Scalds of the pharynx and larynx produce the same condition more rapidly. The boiling

water taken into the mouth from a kettle is not swallowed, but ejected by the violent spasm of the pharynx. However, the scalded membrane instantly becomes violently congested, and œdema sets in. Tracheotomy must be performed if the symptoms of asphyxia rapidly increase, and if hot inhalations have proved useless. Syncope is also common in these cases owing to the acuteness of the asphyxial condition. Often, if the child escape the primary evils just described, the pharynx and larynx become the seat of a fibrinous exudative inflammation which has been called croupous since the mucous membrane is covered with a white fibrinous false membrane. Precisely the same condition may arise from a person swallowing strong acids.

Fractures of the larynx are very fatal accidents. The thyroid cartilage is usually separated into its two halves, and the hyoid bone is not infrequently broken at the same time, under which circumstance movement of the tongue becomes very painful, and the voice is so altered as to be unintelligible. Fracture of the larynx may be immediately fatal from dislocation of the vocal cords, and consequent asphyxia from spasm of the glottis. Or, again, if the mucous membrane is torn the person may be choked with blood, evidence of wound of the membrane being afforded by his coughing up bloody mucus. Finally, œdema glottidis may set in at any time, soon after the accident. Tracheotomy should therefore be performed as a prophylactic measure in all cases of bad fracture of the larynx. Treatment should be limited to relieving symptoms, and attempting to fix the fragments together by strapping the neck lightly; or if the displacement is severe, they should be cut down upon and united with catgut.

Foreign bodies in the air passages.—The substances which may find their way into the air

passages are very various and numerous, but the symptoms produced are so very much alike that a diagnosis, in most cases, is comparatively easy. First, as regards their entry into the air passage, it will not be forgotten that, in order to reach the trachea, a foreign body must pass through the rima glottidis, the least touch of either side of which naturally excites a severe spasm of the glottis, and, consequently, such a body can get into the trachea only when the glottis is widely open. This happens when a person holding a body loosely in the mouth gives a sudden violent inspiration. The foreign body is then sucked into the air passage. A foreign body may be impacted in the larynx above or between the vocal cords, very commonly above, being caught in the mouth of the laryngeal pouches or sacs on either side. Next, it may be loose in the trachea, and, finally, may drop down into a bronchus, usually the right one, because that is in a more direct line with the axis of the trachea than is the left. The symptoms of a foreign body in these different regions of the air passage vary, as does also the treatment.

Impaction in the larynx.—The presence of a foreign body in the larynx usually causes violent spasm of the sphincter-like muscles of the larynx, so that the patient just after the accident is in immediate danger of death from asphyxia; in fact, the majority of patients die at once if the mass impacted is cylindrical and too large to go through the rima glottidis. Such instances are seen in cases where a person has "bolted" large pieces of meat and one has slipped beneath the epiglottis. If, however, the foreign body is thin and flat, albeit very angular and sharp, the patient will probably recover from the first severe spasm of the glottis, and, as air can pass freely past the body, he will survive the accident, having, however, severe attacks of spasm at intervals, with

exhausting cough, and expectorating blood-stained mucus. This accident is to be feared, as specially tending to asphyxial syncope from failure of the heart, a very fatal form of fainting. Examination of the larynx with the laryngoscope must be made at once, and, if the body is seen at the top of the larynx fixed in the aryepiglottic fold, it should be seized with laryngeal forceps and withdrawn (Fig. 100). If deeply impacted, laryngotomy must be performed, and thyrotomy carried upwards for half an inch or so, and the foreign body extracted with as little laceration of the mucous membrane as possible. After thorough cleansing of the parts a laryngotomy tube should be kept in for twenty-four to forty-eight hours, until danger of œdema glottidis has passed away.

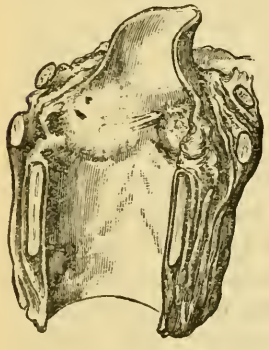

Fig. 100.—Fish Bone impacted in Larynx.

Under certain circumstances, *e.g.* narrowness of the foreign body, etc., persons may tolerate the pressure of a foreign body in the larynx for months.

Foreign body loose in the trachea. — This condition of things is perhaps the most trying to a patient, for two reasons. Firstly, the body, being loose, is coughed up against the lower surface of the rima glottidis; this excites powerful spasm of the glottis, with accompanying asphyxial symptoms of greater or less severity. Secondly, the presence of the loose body excites free secretion from the air tubes of a quantity of frothy mucus, which also suffocates the patient. In one instance I saw a plug of tenacious mucus itself produce urgent symptoms by being driven against the glottis until it was removed by tracheotomy. A patient suffering as

above sits propped up, the air entering the chest badly, owing to the filling up of the tubes, so that the face is livid and the respirations very laboured. On auscultation little air will be found to get to the bases of the lungs, and the air tubes will be full of loud mucous rattling râles. Simple acute bronchitis being excluded by the history, tracheotomy must be done at once; and, instead of a tube being inserted, it is best to pass a carbolised silk loop through each side of the tracheal wound, so that it can be drawn open and the escape of a foreign body facilitated, thus avoiding the hindrance necessarily offered, to a large extent, by the presence of a tube. A dilator (Golding Bird's) is also used for the same purpose. The mucus should be aspirated or sucked out of the trachea as soon as the latter is opened. *When* the air passage is fairly free the patient may be inverted gradually and encouraged to cough; the body, if loose, will probably then be expelled through the larynx or wound. It is imperative obviously to perform tracheotomy when the symptoms of laryngeal spasm are recurring, but now it must be stated that the operation should always be performed as a prophylactic measure if the diagnosis is clear; and a paroxysmal attack of laryngeal spasm is unmistakable. It should be performed because the expulsion of the body is rendered quite safe, since the patient can breathe in spite of the spasm above. This treatment is strongly supported by statistics, which have considerable value in a question like the present. Foreign bodies have been expelled naturally even as long as nine months after the accident, but usually the end of the case is much less favourable.

Impaction in a bronchus, usually the right one. —This condition will be preceded by such symptoms as have been just described. Special symptoms are: Pain at seat of lodgment, no breath sounds

in lung, whistling râles at seat of impaction, especially if the body is tubular, purulent bronchitis, followed by abscess in the lung very frequently, and more rarely phthisis. An attempt should be made to extract the body by passing down the trachea a wire hook and fine forceps, the patient being fully anæsthetised.

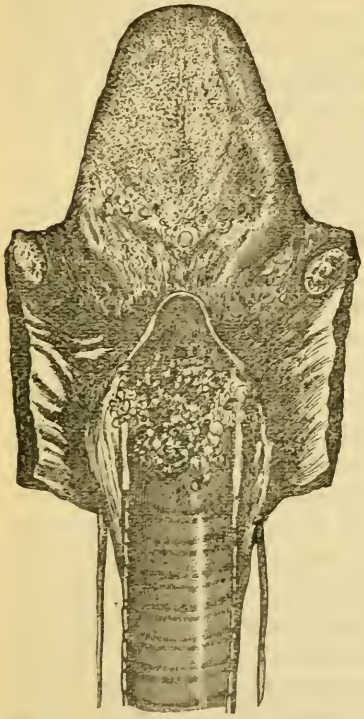

Fig. 101.—Laryngeal Papilloma.

Tumours of the larynx may very well be considered next, since the symptoms they give rise to are practically those of foreign bodies. They are popularly grouped together as polypi. They consist of the following kinds, the commoner being mentioned first :

1. *Papilloma*, or wart, consists of a fibrous framework covered with thin mucous membrane. Laryngeal papillomata are frequently multiple, sometimes sessile, at other times pedunculated (Fig. 101). In children these may grow to a large extent and cause chronic asphyxia, for which tracheotomy has been resorted to in ignorance of the cause. Thyrotomy is the operation to be performed.

2. *Fibroma.*—A roundish smooth tumour, usually sessile, composed of simple fibrous tissue growing from the submucosa.

3. *Adenoma.*—A solid tumour, which begins in the mucous glands and grows in the submucosa.

4. *Epithelioma*, rather commoner than the last, is like epithelioma elsewhere. The disease spreads until it destroys the surrounding tissues, sometimes appearing on the surface of the neck as a fungating sore. The ulcer presents the typical raised thick and hard border, with dirty granulation tissue forming the floor. It implicates surrounding tissues, and infects the neighbouring lymph glands.

5. *Myxoma.* — Myxomatous polypi are found sometimes in the larynx.

The above tumours grow very slowly, as a rule, and, if high up in the larynx, cause practically no symptoms until of considerable size. As a rule they produce alteration in the voice, coughing, and, in severe cases, attacks of paroxysmal dyspnœa. They are detected, of course, by the laryngoscope, and their early removal effected. This may be done in two ways. Either the growth may be seized with laryngeal forceps, snare, or galvanic cautery (the larynx being partly anæsthetised with cocaine), and the instrument guided by means of the laryngoscope; or the thyroid cartilage must be split and the larynx examined. The former operation is styled endo-laryngeal, and requires no further mention here; but a few words must now be said on thyrotomy.

Thyrotomy.—The patient being anæsthetised, and the shoulders raised and the neck stretched, the anterior border of the thyroid cartilage and the crico-thyroid membrane are exposed by free incision. All bleeding having been stopped, the crico-thyroid membrane is opened for a short distance, and then the thyroid cartilage is split up to the top quarter inch, which is left intact to prevent gliding displacement of the two halves. The two halves being now separated, the interior of the larynx is inspected, and all growths

removed. As the mucous membrane is very sensitive and reflex action vigorous, it is best to first paint it with cocaine solution, 10 to 20 per cent. (Parker), and then snip off the growths. All bleeding can be arrested by pressure, and then the sides of the thyroid must be stitched together with fine catgut and the wound closed, except opposite the crico-thyroid opening. A light dressing of carbolic gauze should be applied.

Excision of the larynx.—If the new growth is epithelioma, the larynx must be excised, the operation being performed in the following way: A free incision is made through the superficial structures, and through the deep fascia from the hyoid bone to opposite the third tracheal ring; the trachea is then laid bare above the isthmus of the thyroid gland (which is drawn downwards), freed from the œsophagus, and finally cut across at the second ring and the open lower end plugged with a tampon tube, through which the anæsthetic can be administered, and which at the same time allows no blood to trickle into the windpipe.

The larynx is then freed on each side, the edge of the knife being kept turned towards the part to be removed. In doing this the superior laryngeal arteries will require ligature. The larynx is now separated from the hyoid bone, and finally from the front of the pharynx. The wound should be mopped out with chloride of zinc (40 gr. to ℥j) and dusted with iodoform. The dressing should be a light one of gauze or wool. The patient to be fed by nutrient enemata as long as possible, and then by a tube. When the wound is healed, Gussenbauer's or Foulis's artificial larynx is inserted into the gap so that the patient can talk distinctly.

Laryngitis with especial reference to croup, diphtheria, and the operation of tracheotomy.—There are several conditions of the larynx

to be here noted which are usually termed laryngitis, but the pathological state of which is really specific. Bearing this in mind we may enumerate the varieties of laryngitis as, (*a*) acute laryngitis; (*b*) chronic laryngitis; (*c*) croupous laryngitis; (*d*) diphtheritic laryngitis; (*e*) tubercular laryngitis; (*f*) syphilitic laryngitis.

(*a*) *Acute laryngitis* of a simple character produces symptoms like œdema glottidis, for the simple reason that the latter is present, but are not so urgent, since the causation is simpler. Acute laryngitis, started by catarrh, and causing hoarseness and loss of voice, is sometimes succeeded by urgent symptoms of dyspnœa, etc. It can usually be controlled by the simple application of hot fomentations (mustard, etc.) to the outside of the neck, coupled with steam and benzoin inhalations, the patient being kept in a warm room, and well fed up.

(*b*) *Chronic laryngitis*, evidenced by hoarseness and soreness, with hawking up of mucus, etc., is to be treated laryngoscopically with astringent lotions applied by a proper brush.

(*c* and *d*) *Croup* and *diphtheria* are regarded by many as degrees of the same disease, viz. a membranous inflammation, *i. e.* an inflammation in which there is exuded on the surface of the mucous membrane a fibrinous exudation which forms a white false membrane. This false membrane may be easily detached in a mild case of croup, or is firmly adherent to a raw bleeding surface in a bad case of diphtheria. Croup very often attacks a child suddenly, with an incubation period of only a few hours elapsing before the characteristic brassy cough is heard, and dyspnœa follows. Diphtheria as a rule is preceded by some days of malaise, and the throat symptoms often take a good many hours to develop.

The inflammation of the mucous membrane, followed by the growth of the membrane, passes upwards into the nose (when it is nearly always fatal) and downwards into the larynx, forming sometimes a perfect cast of the air passages (Fig. 102). In the latter case it produces the classical signs of laryngeal obstruction. There is one symptom, however, that forms a strong indication for the performance of tracheotomy, and that is the recession of the soft parts about the chest walls when the patient makes efforts at inspiration. When this is marked, tracheotomy is to be performed at once.

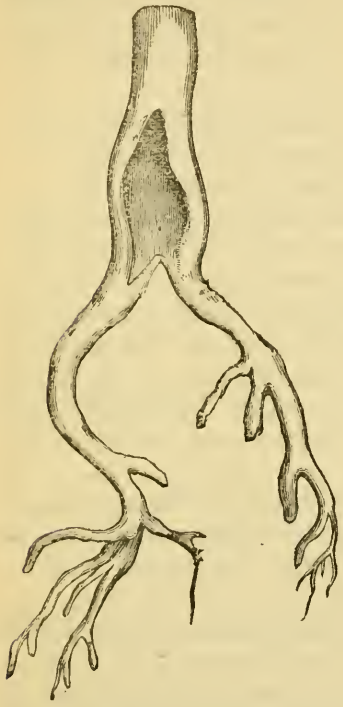

Fig. 102.—Membranous cast of Trachea and Bronchi from a case of Diphtheria. (From Lond. Hosp. Museum.)

(*e* and *f*) *Tubercular* and *syphilitic laryngitis* are the names given to tubercular and syphilitic congestion and ulceration of the larynx. The ulcers are in both cases ragged sores, the edges raised, and the floor sloughy. In tubercular disease there is usually chronic œdema, and in syphilis gummatous masses are often seen. Tubercular laryngitis is usually very painful and fatal, and tracheotomy affords but slight relief. As syphilitic ulceration heals, the cicatrices often contract the larynx so much as to necessitate the operation.

Tracheotomy is one of the most important

"emergency" operations, and therefore one always to be done with every precaution and deliberation if there is reasonable time. The shoulders are to be raised on a firm small pillow, the neck and head thrown back, the former resting in a hollow in a sand-bag, which fixes it and prevents it rolling from side to side. An assistant, holding his fore-arms on each side of the child's head, is ready to open the wound with blunt hooks. An incision is then to be made extending from the crico-thyroid membrane to a variable distance above the sternum. The anterior jugular vein being avoided (Fig. 103), the deep fascia is opened to the same extent as the skin, the depressor muscles of the hyoid are then exposed and the fascial septum between them incised, and the muscles held apart by the hooks. The loose connective tissue covering the isthmus of the thyroid is divided, and the isthmus drawn downwards with a blunt hook, the trachea being exposed then between it and the cricoid cartilage by a few more touches of the knife. A small sharp hook is now stuck into the front surface of the windpipe to steady it while it is opened carefully with the

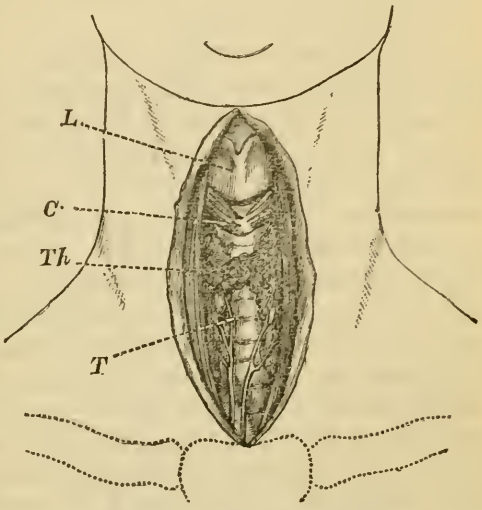

Fig. 103.—Median line of Neck.

L, Larynx; C, cricoid cartilage; T, trachea; Th, thyroid gland.

scalpel, the back being towards the thyroid isthmus. Directly it is opened, the sides of the wound in the trachea must be held apart, and all mucus and false membrane cleared out by feathers, or aspirated by a soft catheter and syringe. When clear, the tube is to be inserted, and tied in. A little carbolised vaseline may be rubbed gently on the wound before the tube is put in.

Complications.—The operation is usually much more difficult than just described, the patient struggling for breath, vessels oozing, etc. Chloroform prevents such struggling (but very little is required), serious bleeding is stopped by forceps as the operation proceeds, oozing always ceasing when respiration is re-established. After the operation the tube wants constant attention. The wound may become sloughy, the neck emphysematous, œdematous, or erysipelatous. Attempts should be made to do without the tube, beginning on the fifth day by stopping the mouth of the tube, and then leaving it out for a few minutes, increasing the interval every day. The operation is of value, not only by relieving the asphyxia, but because it enables the operator to thoroughly clear out the larynx, this being done by passing a feather up from the wound, or passing a string into the mouth and drawing small plugs of antiseptic wool up, as sponges. If the tube and wound tend to dry, so that the discharge blocks it, then the steam kettle must be used to keep the air moist, and at the same time the membrane must be softened with solution of carbonate of soda and glycerine.

XII. DISEASES OF THE NOSE AND NASAL CAVITIES.

William J Walsham.

Wounds of the nose may be inflicted from without, or from within through the nostrils; they may merely involve the superficial structures, or they may be complicated by division of the cartilages, or fracture of the bones. (*See* Art. I., vol. i.)

The parts should be thoroughly cleansed, and brought as accurately together as possible with horse-hair sutures, and the wound sealed with collodion. Even where considerable portions of tissue have been detached, immediate union may be hoped for, as the blood supply of the nose, like that of the face generally, is very free, a fact which also explains the liability of wounds of these parts to be followed by swelling or erysipelas; but if much tissue has been lost, a plastic operation may be subsequently required. When a sharp instrument has been thrust up the nostril, care should be taken that no portion of it is allowed to remain in the wound; and as in such cases the cranium may have been penetrated and the brain injured, rest should be enjoined and the patient watched for any signs of intracranial inflammation.

Epistaxis, or bleeding from the nose, is a common attendant on blows or other injuries, and is a prominent symptom of certain forms of fracture of the base of the skull and of fibrous and malignant growths in the nose or naso-pharynx. It frequently occurs spontaneously. Thus, in children and young adults it is often due to congestion of the mucous membrane, and is especially common in girls about the age of puberty. In the middle-aged it appears to be due to plethoric

habit and congestion of the brain and liver. In the old or cachectic it may depend upon a poor condition of the blood, such as occurs in cirrhosis of the liver, granular kidney, heart disease, scurvy, and in some fevers. The blood usually escapes from one or other nostril, but may pass through the posterior nares and the gullet into the stomach, and, being afterwards vomited, may simulate hæmatemesis, or it may irritate the larynx and be coughed up in a frothy condition and be mistaken for hæmoptysis. Some florid blood, however, will generally escape from the nostril at the same time, and can usually be seen trickling down the back of the throat.

Treatment.—For an account of the treatment required for the various conditions that may give rise to epistaxis the reader is referred to other portions of this work, or to a treatise on medicine. Here it will suffice to indicate the means that may have to be adopted for arresting the bleeding when this is thought advisable. When the result of a blow or other injury of the nose, or occurring spontaneously in the young, the hæmorrhage generally ceases of its own accord, or may be readily controlled by cold sponging, elevation of the arms, and other well-known domestic remedies; whilst in the plethoric, as the result of congestion, it should not be too hastily checked, as it may prevent graver mischief, such as cerebral hæmorrhage. In the old and cachectic the arrest of the bleeding is generally indicated, but may be attended with difficulty. Rest, the sucking of ice, an ice bag to the bridge of the nose, cold to the spine, and cold douches, with the internal administration of gallic acid, lead and opium, ergot or perchloride of iron, may be tried. These means failing, it may be necessary to plug the nares. This may be done either with the inflating tampon, or with pledgets of lint or iodoform wool. An inflating tampon is shown in Fig. 104. It consists of an indiarubber tube

with two dilatations upon it, so sized and shaped that when inflated they may accurately fill the anterior and posterior nares respectively. It is passed through the nostril in a flaccid condition by means of a long probe, and the air after inflation prevented from escaping by twisting and clamping the tube. To plug the posterior nares with lint or cotton wool, a pledget should be made about the size of the last joint of the thumb, and secured round the middle by a piece of twine which has been previously passed through the nostril, round the palate, and out of the mouth by means of a Bellocq's sound, or if this is not at hand, by a gum elastic catheter. The plug can be then drawn into the posterior nares by making traction on the end of the string protruding from the nostril, aided by the fore-finger behind the palate. I have found, however, that the patient is less inconvenienced by pushing a piece of fine soft rubber tubing along the floor of the nose, and when it presents below the palate, drawing it forwards by the forceps and securing it to the twine already attached to the pledget. The anterior nares may next be plugged by a similar pledget, secured by the thread already hanging out of the nostril. The other end of the string attached to the posterior plug may be fastened loosely to the cheek or allowed to fall backwards into the pharynx, and will be of service in the removal of the plug.

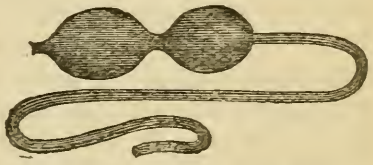

Fig. 104. — Indiarubber inflating Tampon for plugging the Nares in Epistaxis. (Arnold's Catalogue.)

Foreign bodies, such as peas, beads, etc., are often pushed up the nostril by children, and, more rarely, hard substances such as cherry-stones and the like have during vomiting entered into the nasal cavities from behind the palate. They may remain in

the nasal passages for some time without being discovered, but the fœtid discharge to which they almost inevitably sooner or later give rise should lead to a suspicion of their presence. They can generally be extracted by the forceps, or by some of the ingenious screws or curettes invented for the purpose; or they may be freed by the nasal douche sent up one nostril and returned by the other; but Rouge's operation has sometimes been necessary for their removal.

Rhinoliths, or **nose stones,** are formed from the deposition of phosphate of lime and mucus upon either a foreign body or hardened secretion. They give rise to much swelling, nasal obstruction, and a fœtid discharge. They have been mistaken for osteomata, polypi, or even malignant growths. Removal with the forceps, previously crushing if necessary, is the proper treatment.

Nasal catarrh, rhinitis, and **coryza,** are terms used to denote inflammation of the mucous membrane of the nose. The disease may be acute or chronic. As acute catarrh, or cold in the head, falls under the domain of the physician rather than that of the surgeon, the chronic form only will be here described.

Chronic nasal catarrh is most frequently met with in the young, especially in delicate and strumous children. It may be caused by oft-repeated and neglected attacks of acute catarrh, the irritation of noxious dust or vapours, the abuse of spirits and snuff-taking, or the presence of foreign bodies or growths in the nose, or adenoid vegetations in the vault of the pharynx. In infants it may be due to congenital syphilis, and is then known as the snuffles; and in rare instances it has appeared to be the result of gonorrhœal or leucorrhœal infection. Several varieties of the affection have been described, all of which, however, appear to be merely different stages of the

same disease. They will be here classed as (1) simple, (2) hypertrophic, and (3) atrophic catarrh.

(1) The *simple form* is characterised by a thin mucous or muco-purulent discharge, and a congested condition of the mucous membrane, but there is neither thickening, incrustation, nor fœtor. If neglected it may pass into (2) the *hypertrophic form.* In this stage of the disease the mucous membrane, especially over the spongy bones, become infiltrated with inflammatory products, and appears swollen and thickened, and of a deeper red than natural, whilst the glands are stimulated to extra secretion, and pour out a thick muco-purulent discharge. Nasal respiration is obstructed, the voice is altered in tone, the alæ nasi are often contracted and thickened, and their mucous surface covered with scabs. Should the catarrh spread to the naso-pharynx, the discharge may be seen streaking the back of the throat, whence it is continually being hawked up in the form of pellets. Some granular pharyngitis, and perhaps increase of the glandular tissue of the vault, may co-exist, and possibly deafness from the implication of the Eustachian tubes. In severe cases the posterior ends of the inferior spongy bones may become so hypertrophied as to appear in the rhinoscope as two globular, congested tumours, almost blocking up the choanæ. This condition of the mucous membrane is well seen in the accompanying illustrations (Figs. 105 and 106). Occasionally within a few months, but more often after several years, the hypertrophic may pass into (3) the *atrophic* variety. This form, also called dry catarrh, and by some, when attended with fœtor, *simple ozæna,* is apparently due to the shrinking of the inflammatory new formation infiltrating the tissues in the former variety with consequent atrophy and more or less destruction of the mucous glands. The nasal cavities appear preternaturally large, and the spongy bones diminished in

size, while the mucous membrane is pale, dry, and shrunken. The discharge, which is viscid, and secreted in deficient quantity, hardens into greenish-yellow crusts. The disease is generally, though not invariably, attended with a horrible fœtor, due either to the decomposition of the discharge beneath the adherent crusts, or to its retention in some of the adjoining cavities into which the catarrh has spread. When fœtor is present, as it occasionally is during what appears to be the hypertrophic stage, it is probable that atrophy has already set in in some of the deeper recesses. It should be remembered that all three forms of chronic catarrh are unattended with ulceration.

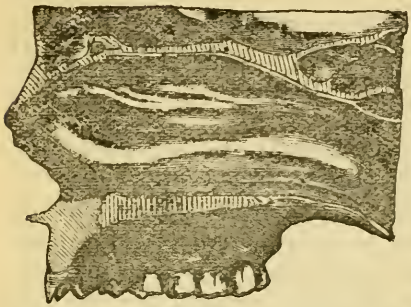

Fig. 105.—Hypertrophy of the Mucous Membrane of the Nose, from a specimen (No. 1762) in the Museum of St. Bartholomew's Hospital. In the recent state the posterior end of the inferior spongy bone resembled a vascular tumour.

Treatment.—Except as the result of congenital syphilis or gonorrhœal infection and in the earlier stages, chronic nasal catarrh is a most intractable malady; indeed, when it assumes the atrophic form little except amelioration of the distressing symptom of fœtor must be expected. In all forms the treatment should be constitutional and local. In strumous

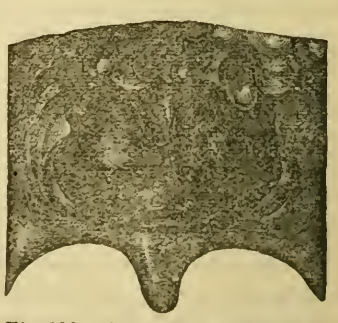

Fig. 106.—Appearances presented by the above on rhinoscopic examination. (After Lefferts.)

subjects cod-liver oil and the syrup of the iodide and phosphate of iron should be persevered in for long periods. In congenital syphilis small doses of grey powder or mercurial inunctions generally act like a charm. Locally, in the simple variety and in milder cases of the hypertrophic, the parts should first be cleansed, either by simply blowing the nose or by the use of some such lotion as that known as Dobell's (acid. carbol. gr. j; sodii bicarb., sodii biborat. āā gr. ij; glycerine ʒj; aquam ad ʒj). Lotions should not be applied, as is too frequently done, by means of the nasal douche, as in this way the deeper recesses and upper portions of the nasal fossæ cannot be reached, and if care is not taken inflammation of the middle ear may be set up. They are better employed in the form of a coarse spray, either by the anterior or posterior nasal spray producer (Fig. 107) worked by the double hand balls. When the parts are thoroughly cleansed, astringents such as the sulpho-carbolate or iodide of zinc, iodoform, tannic acid, or nitrate of silver may be used in the form of sprays, powders, or gelatine bougies. Where there is great hypertrophy, the thickened tissue should be destroyed by nitric or glacial acetic acid, or by the galvanic cautery. In using the cautery, Shurley's speculum (Fig. 108) will be found useful for protecting the septum. When the posterior ends of the inferior spongy bones are much enlarged they may sometimes be advantageously removed by Jarvis' snare, or by the galvanic écraseur. A deflected septum should be straightened, and adenoid growths in the vault of the pharynx should be extirpated.

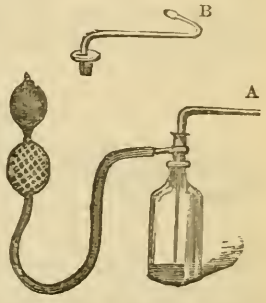

Fig. 107. — Nasal Spray Producer. A, Nozzle for anterior nares; B, nozzle for posterior nares. (Arnold's Catalogue.)

Where the catarrh falls chiefly on the naso-pharynx (*retro-nasal catarrh*), the local remedies should be applied from behind the palate, by substituting the posterior for the anterior nozzle in the various spray producers, etc., whilst cubebs, which appear to exert a special action on the glands of the naso-pharynx, should be given internally. In the atrophic form little can be done beyond cleansing and disinfecting the nasal chambers by means of lotions of carbolic or boracic acid, or Condy's fluid, and the like. Stimulation of the mucous membrane by the local insufflation of the sanguinaria galanga, as recommended by Robinson, and the continued use of Gottstein's nasal tampons, with cubebs internally, may prove of temporary benefit.

Fig. 108. — Shurley's Nasal Speculum, for protecting septum during cauterisation. (Arnold's Catalogue.)

Ozæna (to stink) is a term which has been used very loosely by authors. By some it is applied to all diseases of the nose attended by a fœtid discharge, whilst by others it has been restricted to the fœtid form of atrophic catarrh. It is better, therefore, to regard it as a symptom and not as a disease *per se*. It is generally present in the following affections: (1) Atrophic nasal catarrh; (2) syphilitic, lupoid, and tuberculous ulceration; (3) caries and necrosis; (4) some forms of new growths in the nose and naso-pharynx; (5) certain diseases of the antrum and other air sinuses; and (6) foreign bodies and rhinoliths.

Ulceration in the nasal cavities is generally of a syphilitic, more rarely of a lupoid, and very rarely of a tuberculous nature. Syphilitic ulceration usually occurs in the later stages of syphilis, and is due to the breaking down of gummata in the mucous membrane or beneath the periosteum. It frequently leads

to necrosis and caries of the bones and cartilages, perforation of the septum and sinking in of the nose. Lupoid ulceration is preceded, as elsewhere, by lupoid tubercles; it is most common on the anterior and lower part of the septum, and just within the alæ of the nose, and not infrequently leads to a small perforation. Both forms are attended with a muco-purulent and fœtid discharge.

Treatment. — In the syphilitic form iodide of potassium in full doses should be given, the parts cleansed with antiseptic sprays, and dead bone, if detected, removed when loose. In lupoid ulceration the surface should be scraped with a Volkmann's spoon or destroyed with caustic or the galvano-cautery, and cod-liver oil and arsenic should be given internally.

Caries or necrosis of the cartilages or bones forming the nasal cavities is generally the result of syphilis, but it may be due to struma, lupus, or rodent ulcer, or may follow an injury or long impaction of a foreign body. The bone disease may be secondary to ulceration of the mucous membrane or to the breaking down of gummous material in periostitis or perichondritis. The septum and the spongy bones are the most frequently affected, but caries of the roof of the nose is not infrequent. When the septum is extensively involved the bridge of the nose may fall in; but it is remarkable how much of it may be lost in adults without any marked external deformity. A fœtid discharge, foul-smelling breath, depression of the bridge of the nose, a history, perhaps, of a former injury or of dead bone having come away, and concomitant signs of syphilis or struma, such as perforation of the palate and loss of the uvula, are suspicious of diseased bone, but the diagnosis can only be made certain by striking it with a probe. Though usually in this way readily detected, a prolonged search with the patient under chloroform may be required, and Rouge's operation has had to be

resorted to before it could be found. If the surgeon has a small index finger this may be easily passed through the nostril, and with the finger of the other hand behind the palate a very thorough exploration can be made.

Treatment. — The dead bone, as soon as loose, should be removed, the parts in the meantime being kept as sweet and clean as possible by antiseptic sprays. Removal can usually be readily effected through the nostril, but where this is not possible Rouge's operation may be done.

Tumours or new growths in the nasal cavities are usually spoken of as polypi, of which three forms are generally described: the gelatinous, the fibrous, and the malignant.

Gelatinous or mucous polypi are by far the most common. They occur as soft, gelatinous, semitranslucent bodies of a pale yellow or pinkish colour, and of a globular, pyriform, or ovoid shape, but appearing opaque and shrunken when preserved in spirit. They may be pedunculated or sessile, and are generally multiple, one or two being frequently larger than the rest. They grow from the mucous membrane, and have the minute structure of the myxomata, and are usually covered with ciliated epithelium. It has generally been taught that they most frequently arise from the superior and middle turbinated bones, but, from the recent observations of Zuckerkaudl, it is probable that they generally have a deeper origin in some of the remote recesses of the nose and neighbouring cavities. Rarely they spring from the roof, and very exceptionally from the septum. They have been attributed to neglected chronic catarrh, and by Dr. Woakes are believed to depend upon a chronic inflammatory condition of the muco-periosteum lining the turbinated bones and tells of the ethmoid, attended by necrosis of the osseous crabeculæ; but their etiology is at the best obscure.

Symptoms.—The chief of these are a feeling of obstruction in the nose, increased in damp weather from swelling of the polypus, and in some cases amounting to complete occlusion, the so-called nasal tone of voice, and a mucous, but not, as a rule, offensive, discharge. Amongst other symptoms that may be met with may be mentioned frontal headache, deafness, and loss of smell; whilst recently certain forms of cough, asthma, and epilepsy have been attributed to reflex irritation set up by the presence of polypi.

Diagnosis.—On looking into the nostril they can generally be seen, and may be distinguished from hypertrophy of the mucous membrane over the spongy bones, for which they are most likely to be mistaken, by the characters already enumerated, and by the light or dark red appearance of the latter. But when high up or far back the speculum or rhinoscope may be necessary to detect them.

Treatment.—They can generally be removed by the polypus forceps; but the use of the galvano-cautery is preferable, as with this there is less pain and little or no hæmorrhage; pain, moreover, may be prevented by the application of cocaine. When the polypus projects in the naso-pharynx, it can be removed from behind the palate either with the forceps or with the galvano-cautery. Tannic acid used as snuff is said to prevent a recurrence, but the author has not found it of much service.

Fibrous polypi rarely arise from the interior of the nose. They more frequently originate in the naso-pharynx from the basilar process of the occipital or body of the sphenoid, or in the cavity of the antrum, and only secondarily invade the nose as they grow larger. When arising in either of the first two situations they are generally designated *naso-pharyngeal polypi.* They spring from the periosteum, and consist chiefly of fibrous tissue, in which spindle-shaped cells are not

infrequently found. They are covered by a very vascular mucous membrane, and contain numerous large thin-walled blood-vessels, which give to them in places almost a cavernous structure. At first generally broadly pedunculated and confined to one side of the naso-pharynx, as they increase in size they assume a very irregular shape, invading the nasal cavities and the rest of the naso-pharynx, perhaps pushing forward or projecting below the palate, or penetrating into the orbit or spheno-maxillary fossa, or even protruding externally through the cheek or into the interior of the cranium.

Symptoms.—At first these may be slight, but sooner or later there will be obstruction of one or both nostrils, attended by a mucous and often foul-smelling discharge, repeated attacks of hæmorrhage, and perhaps deafness or trouble in breathing and swallowing; whilst later, as the bones are invaded and displaced, the face assumes the characteristic appearance known as "frog-face." They are most common in young adult life, and, if not removed, may produce fatal exhaustion from the repeated hæmorrhages, though in some instances they have undergone atrophy as the patient grew older. They may be known by their firmness, smoothness, dark red colour, and proneness to bleed on examination.

The *diagnosis* is readily effected by the aid of the rhinoscope or the finger passed behind the soft palate, while at times they may be seen with or without the speculum on looking into the nostril.

Treatment.—Removal by the galvano-cautery, the wire being passed through the nares and directed over the base of the growth by the finger behind the soft palate, the base being afterwards destroyed by Lincoln's electrode, is, perhaps, the best treatment when the polypus is of moderate size. If too large to admit of this, an attempt may be made to reduce it within removable

limits by electrolysis; or, this not being considered advisable, an exposure of the growth must first be obtained in one of the following ways, and its removal then accomplished either by the galvano-cautery or écraseur. If chiefly confined to the naso-pharynx, exposure is best obtained by splitting the soft palate, and if more room is still required, by chiselling away part of the hard palate as well (Nélaton's method); or, when chiefly invading the nasal cavities, by turning back the ala of the nose after splitting the upper lip in the middle line, or even removing the superior maxillary bone. Rouge's operation of turning up the upper lip and cartilaginous portion of the nose, and Langenbeck's method of resecting the maxillary bone, have each their advocates, but I have not found exposure by the former so good as that by turning back the ala after splitting the lip, and the resection of the maxillary bone is certainly attended with greater risks than its mere removal.

Malignant polypi may have either a sarcomatous or carcinomatous structure, and may arise in the nasal cavities, naso-pharynx, or antrum. The symptoms attending them are similar to those of the fibrous variety already described; but they grow more quickly, infiltrate as well as invade surrounding parts, and sooner or later involve neighbouring glands. A microscopical examination of a small portion will reveal its exact structure. Early and complete removal, when there is a fair prospect of being able to get away the whole growth, is the treatment that should generally be adopted.

Adenoid vegetations consist of sessile, pedunculated, or fringe-like growths, due to hypertrophy of the adenoid tissue, so abundant in the vault of the pharynx and in the region of the choanæ. They are most common in childhood, and are of more frequent

occurrence in northern Europe than in this country. They have been attributed to cold and damp, the exanthemata, etc., but their etiology is obscure. *Symptoms.*—Obstructed breathing in infants, and in older children deafness, are usually the symptoms that first attract attention. The voice has a peculiar tone, described by Meyer as of a "dead" character. The countenance has a vacant expression from the breathing, in consequence of the nasal obstruction, being carried on through the half-open mouth, whilst nasal catarrh, granular pharyngitis, enlargement of the tonsils, and purulent otitis, are not infrequently present.

The *diagnosis* can be readily made by passing the finger behind the palate, and by the aid of the rhinoscope. To the finger they feel soft, yielding, irregular, pulpy, and velvety, like a bag of earthworms as Meyer puts it; whilst in the mirror they appear as irregular, pink or reddish, sessile or pedunculated, fringe-like masses, partially obscuring the posterior nares. Bleeding commonly attends the examination.

Treatment.—Though they have a tendency to atrophy as the patient gets older, removal is generally called for, as they may lead to permanent deafness. This in slight cases may be effected by the application of solid nitrate of silver or astringent solutions. The softer varieties may be scraped off with the finger nail, whilst the larger and firmer may perhaps best be removed by Loewenberg's forceps, guided by the mirror or finger. Those near the Eustachian tube require careful management lest the tube be injured, and may most conveniently be destroyed by Meyer's ring knife, which is passed through the nose, or by a small galvano-cautery guided by the mirror with the patient under chloroform and the soft palate tied up.

Congenital deformities of the nose are rare and of little surgical interest. The only one to which

reference need be made here is occlusion of the nostrils. An incision, where this is merely membranous, will generally suffice, but in some cases a plastic operation will be necessary.

Diseases of the exterior of the nose.—The affections to which the external parts of the nose are most liable are: lupus, rodent ulcer, epithelioma, acne rosacea, and lipoma nasi. These, with the exception of the last named, present, when attacking the nose, no special features, and the reader is referred for a description of them to Arts. v. and xxiv., vol. i.

Lipoma nasi is a hypertrophy of the sebaceous follicles and surrounding skin and subcutaneous tissue, not, as the name seems to imply, of the fatty tissue. It has been ascribed to exposure and alcoholism, and is most common after middle age. The tip and alæ of the nose are chiefly affected, being transformed into irregular, lobulated, prominent, or pendulous masses, on which the apertures of the hypertrophied glands are seen as pit-like depressions. Occasionally pale, they are perhaps more often of a purplish-red colour, and traversed by dilated capillaries.

Treatment.—The masses should be shaved off with a sharp scalpel, care being taken not to penetrate the cartilages. The improvement, when the parts have cicatrised, is very marked.

Affections of the septum.—*Blood tumours* are occasionally met with as the result of fracture of the septum or other injury. The blood is extravasated between the cartilage and the soft tissues, causing a circumscribed, fluctuating swelling, often on both sides of the septum, which may readily be distinguished from abscess by its appearing immediately after the injury and by the absence of inflammation. The blood, as a rule, is slowly absorbed, but may break down into pus. In the latter circumstance only should an incision be made into the swelling.

Abscess may occur after an injury, breaking down of a blood tumour or gumma, and sometimes without any evident cause. The signs of inflammation and fluctuation serve to distinguish abscesses from other tumours. They should be opened early.

Cartilaginous and osseous tumours forming outgrowths from the septum and projecting into the nostril are sometimes met with. The absence of a depression on the opposite side distinguishes them from deviation of the septum. They may be removed either by the knife, saw, or dental engine.

Deviation of the septum to one or other side may occur as the result of a blow or fall upon the nose, or as a congenital malformation. It appears as a swelling projecting into and more or less obstructing one of the nasal cavities, and may readily be distinguished from a polypus, for which it has sometimes been mistaken, by the presence of a corresponding depression on the opposite side. It is generally attended with some lateral deviation, and perhaps depression in the case of injury of the lateral cartilages or even of the nasal bones. The inferior turbinated body on the side corresponding to the concavity is often much hypertrophied. The *symptoms* commonly complained of are obstructed nasal respiration, altered tone of voice, and a continual chronic catarrh; whilst sometimes frontal headache, giddiness, and certain other distressing symptoms referable to nasal obstruction are present.

Fig. 109.—Walsham's Forceps for straightening Septum. (Arnold's Catalogue.)

Treatment.—The septum may generally be forcibly straightened. I have found the forceps shown in the woodcut, which are a modification of Adams', best for the purpose, the large bows below the blades protecting the columnella. The straightened septum

should then be kept in position by retentive apparatus; the hollow plugs made for me by Messrs. Arnold will be found useful for this purpose. In some cases portions of the prominent septum may be advantageously excised. Deviated cartilages should be rectified at the same time, and even where the bones have been displaced they may be straightened even after many years. Great force, however, is often necessary, and the forceps must be carefully padded to prevent injury to the soft parts. In these severe cases I have found the mask shown in Fig. 110 of service, as in its use a fixed point is gained to bear on the displaced parts.

Fig. 110.—Walsham's Mask for making Pressure on crooked Nose. (Arnold's Catalogue.)

XIII. DISEASES OF THE EAR.

GEORGE P. FIELD.

Specific functions of the auditory apparatus.—The perception of sound is commonly due to motion of the chain of ossicles connecting the tympanic membrane with the internal ear, the intralabyrinthine fluid of which, being set in vibration, occasions disturbance of the processes of the organ of

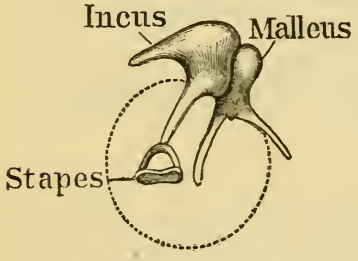

Fig. 111.—The Auditory Ossicles viewed from within the Tympanum (enlarged).

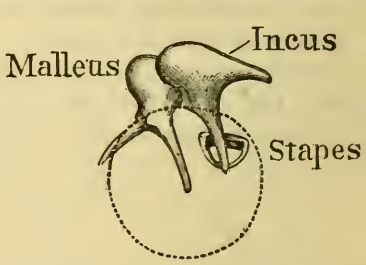

Fig. 112.—The Auditory Ossicles viewed from within the External Meatus (enlarged).

The dotted line indicates the position of the drum-head.

Corti and of the cochlear and ampullar air cells, with concussion of the otoliths contained in the endolymph of the utricle and saccule. The differentiation of sonorous impulses is presumably rendered possible by their passage through the whole length of the perilymph to affect the endolymph. Sounds not conveyed by the ossicles may travel to the membrane of the fenestra rotunda across the middle ear, or more directly, and seemingly to the cochlea and ampullæ, through the bony labyrinth or the skull.

Of the ossicles, the stapes is that most essential, serving, in common with the membrane of the fenestra

ovalis, to dam back the fluid of the internal ear. Of the labyrinth, biology indicates the vestibule to be fundamentally the most important part. Intensity of sound appears to be interpreted by the vestibular nerve, and difference in tone by the organ of Corti. Cyon's view, that the semicircular canals are the peripheral organs of the sense of space, seems probable.

The Eustachian tube serves (1) to maintain equality of atmospheric pressure on the tympanic

Fig. 113.—Brunton's Otoscope in use.

membrane; (2) to drain off excess of mucus; and (3) to prevent echo by affording passage for sonorous undulations from the middle ear. The inner end is generally considered to be opened only at the conclusion of deglutition.

Examination and treatment of patients.—In children, the external auditory canal, it must be remembered, differs from that of adults in being less in its vertical than in its horizontal diameter. Of otoscopes, Brunton's is that most universally serviceable (Fig. 113); but usually a concave mirror, with a forehead strap for use if required, and an ordinary silver ear speculum, suffice.

A healthy drum-head appears of a delicate blue-grey colour, and through it is seen the handle of the malleus running downwards and backwards, with the apex of the white spot at its extremity.

To test a patient's hearing power, bring the watch or other sound-producer gradually to the ears, and make a note of the distance at which it is first audible. Conversational tests must be applied so as to preclude lip-reading. It should be borne in mind that the relative audibility of different sounds may vary with the patient's condition. The tuning fork applied to the forehead distinguishes betwixt mere obstruction to the passage of sound reaching the meatus and defect in the auditory nerve (*i.e.* betwixt impairment of the sound-conducting and the sound-perceiving capacity of the ear), its vibrations in the former case being by reverberation considerably intensified, although the ear may be totally insensitive to aerial sound waves. Diminished audibility of bone-conducted sounds may be due to (1) senile changes in the auditory nerve, or (2) to acute otitis.

Whispering, in which diminution in the vowel sounds renders the consonants the more easily distinguishable, is usually better heard by the deaf than ordinary speech. Increase in the apparent perception of high musical tones is said to indicate greater though limited tension of the drum-head, or breach of its substance, admitting the easy passage of short sound waves to the labyrinth. The audibility of high sounds is best arrived at with the aid of König's rods, or Galton's whistle. Paracentesis Willisii, or improvement in the hearing of some deaf persons during noise, is compatible with very different conditions of the drum, and may be due to an exaltation by the noise of the impaired functions of the auditory nerve, without the creation of corresponding auditory impulses. Another and perhaps more probable explanation is, that the

improvement in a noise is consequent on the extra shaking of ossicles which have become fixed from some catarrhal inflammation.

Diseases of the external meatus of the ear.—*Impacted wax* in the ear can usually be removed by gentle syringing with water at 100° F.; in some instances it should be previously softened by the installation of warm solution of bicarbonate of soda (gr. x ad ℥j), which is especially useful in examples of keratosis obturans (over-accumulation in the meatus of epithelial laminæ).

Abnormal dryness of the external meatus may be indicatory of disease of the internal ear. Fluidity and offensiveness of cerumen in children, if not corrected, are apt to lead to catarrhal inflammation or worse results.

With patients complaining of *foreign bodies* in the meatus, it is well to ascertain, by means of the speculum, that there is actually anything foreign to be removed. Avoid, where possible, instrumental interference, to which complete inaction may be preferable. Careful syringing along the roof of the meatus, the auricle being drawn upwards and backwards, is generally all that is required, the patient, if necessary, being placed on his side or back. But this treatment should not be adopted if the foreign body has occasioned much swelling of the soft parts; in this case the inflammation should be relieved by leeching freely in front of the tragus. The offending substance may sometimes be removed by affixing it with glue or coaguline to a piece of linen or a brush, or by the use of adhesive plaister on a string. If it is swollen by absorption of moisture, the use of glycerin may be effectual. In some cases an anæsthetic is necessary. Epileptiform convulsions or symptoms like those of Ménière's disease sometimes result from irritation caused by foreign bodies in the meatus.

For *boils* in the meatus, poultices (not admissible in other instances of aural inflammation), glycerine applications to relieve pain, and lancing and subsequent treatment with boracic acid, should be resorted to. Defective house-drainage is said to be the cause of abscesses in the ear.

Insects or their larvæ in the auditory canal can be destroyed by warm oil or chloroform vapour, and then removed by syringe or forceps.

Aspergillus, the fungus most usually met with in the ear, follows on eczema or other inflammation affecting the epidermis. Its growth is fostered by a damp, ill-ventilated atmosphere. With the symptoms characteristic of inspissated cerumen, it causes dull pain. It is best combated by frequent applications of solution of lead acetate, chlorinated lime, or of potassium permanganate, or by chlorine, bromine, and iodine water, or applications of alcoholic 2 to 4 per cent. solution of salicylic acid.

Narrowing of the meatus from chronic inflammation indicates recourse to constitutional remedies, and locally the application of strong solution of silver nitrate, or of ointment of ung. hydrarg. nit., and ung. zinci (1 to 8). The insertion of a series of lubricated short imperforate drainage tubes may at times be useful. Erysipelas, molluscous or sebaceous tumours, and various other causes of stenosis must, of necessity, receive specific treatment.

Otorrhagia (bleeding from the external auditory meatus) usually results from polypus, or it may be due to injury to the base of the skull or to the internal carotids, the membrana tympani, or the walls of the meatus. It may occur also in purpura, yellow fever, and malignant small-pox, in acute aural catarrh, in Bright's disease, in the condition known as otitis hæmorrhagica, and in suppression of the menses.

"*Ear cough*," due to irritation of the external

auditory meatus or of the outer layer of the drum-head, is regarded as a reflex result of affection of a branch of the pneumogastric supplying the same.

Diminution in the calibre of the external auditory canal from diffuse thickening of its bony walls may be treated by the insertion of small ivory bougies. The commonest bony outgrowths, or *exostoses*, in the meatus originate usually in inflammation of the middle ear, are of rapid growth, and mostly pedunculated. Being of the nature of spongy osteomata, they can be removed by the écraseur. In minute structure they resemble newly-formed bone. The majority of the multiple outgrowths, which are commonest in the wealthy classes, are more compact, and histologically comparable with syphilitic nodes on the cranial flat bones. True ivory exostoses, or hyperostoses, are still denser in structure, and of rarer occurrence; are painless, and usually bilateral; and are the effect neither of active inflammatory changes nor of congenital tendency, but apparently of a chronic irritation of the meatus, such as is producible (as the author first pointed out) by constant sea-bathing. For their removal, drilling with Matthewson's dental engine has proved the most effective measure. During the operation a steel guard is needed to protect neighbouring structures.

Fig. 114.—Multiple Exostoses bounding a Triangular Opening.

Diseases of the auricle and associated parts.—*Malformations* may be due to defective or excessive developmental activity in the tissues bounding the first post-oral cleft, in the minute folds of which dermoid cysts in the external meatus probably originate.

Among other affections of the auricle are warts, chalk stones in the upper part of the helix in gouty persons, epithelioma, keloid growths, and cicatrices caused by ear-ring punctures, traumatic and idiopathic othæmatomata, or blood tumours, herpes, erysipelas (usually chronic), and syphilitic eruptions.

Idiopathic *othæmatomata* usually occur in the insane, and are pathognomonic of disease of the base of the brain. In eczema of the auricle it is important to ascertain that topical applications are not being rendered useless by uncured otorrhœa. Contagious impetigo of the auricle requires, first, removal of scabs, and then destruction of pus by carbolic lotion and mercurial ointment. Chilblain is best treated by warmth and spirit liniment, and pruritus by soothing lotions and ointments containing opium, creasote, hydrocyanic acid, and mercurials. Ichthyosis of the auricle is alleviated by the continued application of glycerine. For lupus erythematosus treat by early inunction with cod-liver oil, followed by scarification and general tonics.

Fig. 115. — Othæmatoma.

Syphilis, either secondary or tertiary, has been observed to affect the ear (probably both the middle ear and labyrinth), by bringing on (1) changes in the drum-head; and (2) deafness, which is usually painless and unilateral, is rapid in onset, and is like that produced by obstruction in the meatus, so that by bone conduction a tuning fork is better heard in the affected ear. Again, syphilis attacking the labyrinth or auditory nerve may cause deafness, commonly absolute, of one or both ears, the healthy ear alone being then sensitive to bone-conducted sound. Syphilitic throat disease

is a not uncommon origin of acute aural catarrh. Nervous deafness from hereditary syphilis generally comes on between the ages of 10 and 16, together with chronic interstitial keratitis, and is much more common in girls than boys. Undoubtedly the best treatment is the administration of grey powder; but the prognosis is unfavourable.

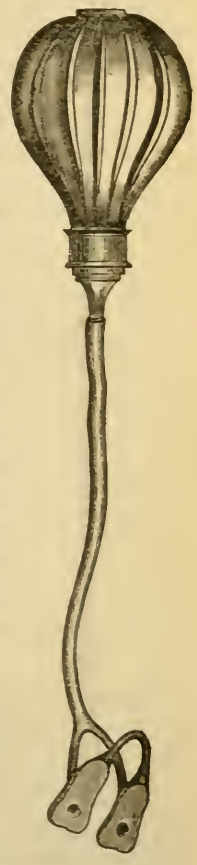

Fig. 116. — Politzer's Bag, with Nasal Pad.

Aural catarrh.—Acute aural catarrhal inflammation, usually unilateral and the result of catching a cold, is characterised by increased vascularity of the drum-head, and by continuous intense pain preceding the discharge, as also by pain on eructation or forcible expiration, and in children notably by intolerance of rest of the head on the side affected. Convulsions are an occasional complication. Fomentation by instillation of warm water, mild purgation, the careful use of Politzer's bag to favour escape of pent-up pus from the Eustachian tube, and also leeching in front of the tragus, are the usually efficacious modes of treatment. Simple acute non-suppurative catarrh rarely causes perforation of the drum-head. It may originate in inflammation of that structure only (myringitis). Foul air and also over-doses of quinine have both been known to produce aural catarrh. In cases of chronic catarrh attention should be given especially to the promotion of the general health by the use of warm clothing, by the administration of cod-liver oil, and

also by the application of astringents to the throat and of iodine over the mastoid process; inflation of the tympanum with Politzer's bag, or with simply a piece of rubber tubing in the case of children, may often prove of great value.

Fig. 117.—The Eustachian Catheter.

Politzerisation, commonly practised at the moment of swallowing, may be promoted also by the pronunciation of certain syllables (as "huck"), or by puffing out the cheeks. The diagnostic or auscultation tube, one end of which is placed in the patient's, the other in the surgeon's ear, enables the observer, by the sound, gurgling or whistling, at the moment of politzerisation to ascertain the existence of fluid in the tympanum or of a perforation in the drum-head.

Excision of the tonsils and prolonged treatment of the naso-pharynx may be necessary in cases of deafness from continued closure of the Eustachian tube, one evil result of which is to cause inward bulging of the drum-head from exhaustion of the tympanic air.

In aural catarrh unbenefited by politzerisation, the Eustachian catheter must, except with children, be employed. To those who are unaccustomed to the instrument, the following method of using it will be found serviceable. It should be passed along the floor of the nares to the posterior wall of the pharynx, withdrawn, and turned inwards to hook round the vomer, and then semirotated downwards till the point is directed outwards and slightly upwards, when it enters the mouth of the Eustachian tube. The introduction of air or fluids into the tube is best effected

through a piece of indiarubber piping connected with the injector or indiarubber bag, which is suspended from the operator's coat, and is compressed with the right hand while the left steadies the catheter. Variable hearing is a pretty sure sign of defective action of the Eustachian tube. Its intermittent and progressive

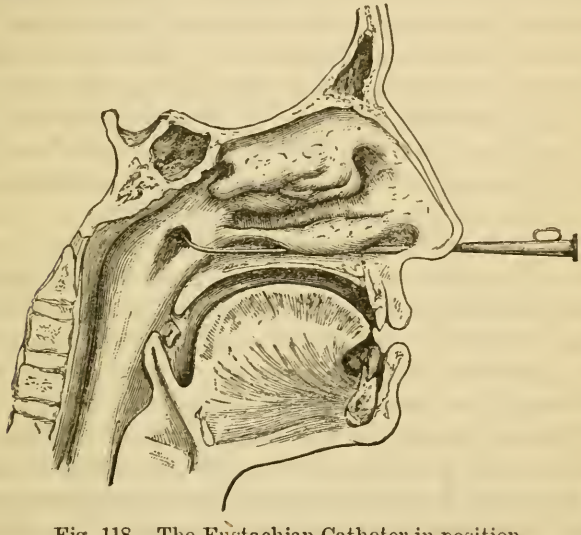

Fig. 118.—The Eustachian Catheter in position.

dilatation by bougies introduced through a catheter has been successfully practised by Ménière and others.

In chronic non-suppurative inflammation of the middle ear, vapours of ammonium chloride are recommended in a catarrhal and simple or iodised aqueous vapour in a dry condition of the mucous membrane; but injection of astringent and slightly stimulating fluids is often useful.

Daily massage over the mastoid region is recommended by Eitelberg for acute and subacute middle-ear catarrh.

Where the cause of **deafness** is due, not to

deficiency of atmospheric pressure but to thickening of the mucous lining of the middle ear, or to adhesions within the tympanum, the local effect of solution of potassium iodide (gr. x ad ℥j) is beneficial; and, similarly, weak solution of iodine, copper sulphate, potash, silver nitrate, or of chloral hydrate may be very efficacious, as well as the internal administration of potassium iodide and mercury perchloride, these last particularly in strumous patients. The severance of adhesions is sometimes to be effected by the use of a pneumatic tractor. Bing, of Vienna, states that words spoken into the Eustachian catheter are not heard if the stapes is fixed, fixation of the malleus and incus alone not preventing their audibility.

Adenoid vegetations in the pharynx may be the source of deafness by closing the mouth of a healthy Eustachian tube, or by so blocking the nares that swallowing occasions rarefaction of the tympanic air. These growths may be removed very easily with instruments, or even with the finger nail.

Serous effusions in the tympanum are commonly absorbed after politzerisation. Where catheterisation does not avail for syringing out the tympanum, puncture of the drum-head may be of value. This should be effected in the lower portion, before or behind the handle of the malleus. The tympanum can then be evacuated by inflation, or by the use of a Siegle's speculum. Paracentesis is required also when, in acute suppurative aural inflammation (a possible sequela of scarlet fever, typhoid, typhus, diphtheria, and other diseases), pus pent up in the tympanum fails to burst through the membrana tympani, or to escape through the Eustachian tube, and so causes the drum-head to bulge outwards. Spontaneous perforation is otherwise a probable event; but in some cases the accumulated pus rapidly produces fatal meningitis or cerebral abscess.

Otorrhœa, or discharge of the pus from the middle ear, is not necessarily ushered in by acute otitis, being *e.g.* a common symptom in struma. For treatment, the main indications are restoration of the general health, thorough cleansing of the ear, and frequent syringing with warm water, and afterwards the application of lotions containing zinc salts, carbolic acid, or rectified spirits. These various astringents should be changed occasionally. Counter-irritation behind the ears, and the insufflation of powdered alum, iodoform, or boracic or salicylic acid, and repeated applications of boroglyceride, may be very useful. The origin of inflammation in an atmosphere contaminated with sewer gas must be guarded against. The introduction into the tympanum of a medicated fluid poured into the meatus may, when a very small perforation in the drum-head exists, be simply effected by Valsalva's method of closing the mouth and nostrils, and blowing, the bubble of air then conveyed by the Eustachian tube being replaced, as it passes out through the drum-head, by a drop or so of the fluid. Neglected otorrhœa may become chronic, and may cause polypus, thickening of the drum-head, destruction of the ossicles, and caries of the mastoid, or even facial paralysis, hæmorrhage from the carotid artery, inflammation of the brain, epilepsy, or by the formation of thrombi in the lateral sinus or the jugular, pyæmic lobular pneumonia.

Affections of the membrana tympani.—Traumatic slits or cuts in the membrana as a rule heal readily, and the tendency in cases of direct injury generally is towards recovery. Perforations from disease, however, are apt to become permanent, if otorrhœa be not arrested, and the health of the middle ear restored. A perforation is not incompatible with fair audition, its position and the state of the ossicles having considerable influence. Deafness owing to a

perforation or to separation of the ossicles is sometimes greatly benefited by the pressure or support afforded by an artificial membrane or a plug of cotton wool, which may be suitably combined. Dr. C. W. Tangeman has recorded a case of double perforation successfully treated by skin grafting. Mammilliform perforations may be effectually treated by instillation of rectified spirit, as shown by Professor Zaufal.

Disease of the mastoid process is characterised by deep-seated local pain and signs of inflammation. Early and thorough incision over it down to the bone, followed by free leeching, repeated washing with antiseptic and astringent lotions, and treatment of the general health should invariably be resorted to. Should these measures fail, in order to obviate the dangers of retention of pus, trephining about a quarter of an inch behind the meatus and a little below the level of its upper wall, or the removal of carious bone by knife or probe is necessary.

Polypi of the ear, generally due to catarrh therefrom, are composed of tissue which is either (1) soft and granular; (2) mucous; (3) fibrous; (4) hyaline or gelatiniform or myxomatous, the last being the rarest. Their common seat is the tympanum.

Granulation tissue in the ear, if not amenable to the treatment for aural catarrh, or to the instillation of rectified spirit, or touching with perchloride of iron, may require removal by scraping.

For the larger polypi excision with a snare such as Wilde's, and subsequent cauterisation of the root with saturated solution of nitrate of silver with chloracetic or chromic acid, and removal of the cause, comprise appropriate treatment. Mucous polypi may be shrunk or, if small, obliterated by repeated instillation of rectified spirit.

Abscesses of the brain due to ear disease are usually single, and situate in the white matter

of the hinder part of the middle lobe, the posterior lobe, or the cerebellum.

Pain in the ear, if not the result of a recognisable affection of the meatus, points either to simple catarrh, or to more or less acute, and hence dangerous, otitis interna. Pain caused by an affection of the ear may not, however, be distinctly referable to that organ. Conversely, aural neuralgia may be caused by dental caries or by general malarial poisoning.

Disease of the internal ear, *i.e.* of the labyrinth and its contained structures, rarely primary, is secondarily of either traumatic or constitutional origin. Traumatic causes are repeated concussive shocks, injuries to the brain, or local lacerations, and effusion of blood or serum; and the constitutional include developmental defects, exposure to cold, rheumatic degeneration, middle ear affections, fevers, mumps, syphilis, meningitis, and sometimes tabes dorsalis. Lesion of the internal auditory apparatus is distinguished by deficient perception of both cranially and aerially conducted vibrations; the patient suffers from true nervous deafness. Nervous deafness dependent on hyperæmia of the labyrinth is at once relieved by leeching and blistering behind the ears.

Ménière's disease is by some authors understood to be simply hæmorrhage into the semicircular canals; by others it has been more comprehensively defined as an abnormal nervous irritation in the semicircular canals, or inflammation in these or the middle ear, causing vertigo. Its vital or medullary symptoms (*e.g.* faintness, perspiration, irregularity of pulse) have been held due to affection of the cochlear nerve, and its locomotor or cerebellar symptoms (vertigo with or without reeling) to affection of the semicircular canals. In cases regarded as typical the giddiness is usually preceded by a feeling of vertical rotation, and is accompanied by that of forward and backward

movement about a transverse axis. Subjective auditory sensations are common. The attacks tend to merge into an habitual vertiginous state. Counter-irritation behind the ears, large doses of potassium bromide, and also quinine and ammonium chloride, are useful in many instances. As vertigo may be produced in a variety of ear lesions, the discovery and treatment of the cause must be aimed at.

Electricity in aural disease.—The induced electrical current has been successfully employed in several cases of intratympanic disease; and stimulation of the ear muscles by the continuous current is sometimes beneficial.

Tinnitus aurium, or persistent subjective sound in the ears, when not ascribable to sympathetic or to cerebral stimulation of the auditory nerve, would appear to be usually the result of abnormal pressure upon the labyrinthine nerve fibres, which again is generally due to some affection of the drum-head. It may be dependent on spasm of the tensor tympani and stapedius, or on the existence of free fluid in the tympanum, and may occur also as a symptom in various disturbances of the circulation, in debility, alcoholism, exophthalmos, and other conditions. For its alleviation have been employed medicinally pilocarpine injections, zinc valerianate, digitalis, arnica, ammonium chloride, quinine and morphia combined, and hydrobromic acid, and locally chloroform vapour and warm glycerine and laudanum for the meatus, strychnine solution injected through the Eustachian catheter, the air douche, faradisation, and section of the posterior fold of the membrane. Autophony, or the hearing of one's own voice in the head, a symptom in sundry aural affections, appears to result from defective mechanical action of the membrana or the ossicles.

Deaf mutism, or deaf-dumbness, affects on

an average one person in some 1550, and males more than females. It is congenital or acquired, according as produced by causes arising before birth (consanguinity, heredity, syphilis, inebriety, *e.g.*) or after birth (as fevers, scrofula, catarrhal inflammation, and falls and blows). It is rare that the immediate parents of deaf mutes are deaf and dumb. For the acquisition of speech by deaf mutes the German or pure oral method is that best adapted, the pupil learning both by personal practice and by ocular demonstration (lip-reading) the mechanism of speech.

Instrumental aids in deafness.—Of the various instruments for the improvement of hearing by reflection of sound a hollow cone is the simplest and most efficient. Small globose or conical resonators may be of great benefit. Hearing through the teeth may be rendered possible by the use of the audiphone or one of its numerous modifications.

XIV. DISEASES OF THE EYE.

R. Marcus Gunn.

Diseases of the Eyelids.

Anatomically the eyelid is a complex structure, and its diseased conditions are correspondingly varied in character; its skin and cutaneous glands, conjunctival mucous membrane, muscles, Meibomian glands, tarsal "cartilage," and eyelashes, with their follicles and sebaceous glands, are all liable to be affected. Again, the position of the lid is such that any departure from the healthy condition readily causes discomfort. Paralysis of the muscles and affections of the conjunctiva of the lid will be more appropriately considered later.

Blepharitis.—The edges of the lids are specially prone to disease, and principally to a chronic form of inflammation known as marginal blepharitis. In the more severe forms of this affection the palpebral border is dusky-red, swollen, and covered with hard, dark yellow crusts. On removing these latter a moist surface is exposed, often with ulceration or small yellow pustules round the insertion of eyelashes; sometimes there is eczema of the neighbouring skin. If neglected, the ulcers may damage or even destroy the cilia follicles, leading to badly developed, misplaced lashes (*trichiasis*), or to more or less complete absence of them. Sometimes we get ectropion from hypertrophy of the conjunctiva, and epiphora from eversion of, or other interference with, the puncture. In the milder forms there is hypersecretion from the sebaceous glands, leading to the formation of small, yellowish-white crusts, on removing which we find

the underlying surface somewhat reddened but not ulcerated. Sometimes we have mere redness of the edges of the lids, especially in persons with delicate skin and light complexion, often associated with some error of refraction and consequent straining of the eyes. This condition is also liable to be caused by external irritation, as exposure to dust or cold. The more severe cases usually occur in strumous children, and frequently date from an attack of measles.

Treatment.—In all cases we must attend to the general condition of the patient, syrup of the iodide of iron or other chalybeate being frequently indicated. External irritants and over-use of the eyes are to be avoided, and glasses ordered if necessary. Locally, our treatment must be directed principally to removing the crusts and preventing their re-formation. Warm alkaline lotions (*e.g.* 10 gr of biborate of soda to the ounce of water) are to be used several times daily, the softened crusts then picked off, and dilute nitrate of mercury ointment (1 part to 7 of vaseline) applied to the roots of the lashes. In very severe cases all the affected lashes should be pulled out and the excoriated surface of the lid touched with a strong solution of nitrate of silver (20 gr. to the ounce). When the lashes have been destroyed and the lids everted (*lippitudo*) we cannot hope to restore a healthy condition, but cleanliness, astringent lotions, and slitting the everted canaliculi will cause much improvement.

The crab-louse occasionally takes up its abode on the edge of the lids, and its eggs are then found disposed along the sides of the lashes like little dark beads. At a superficial glance the condition might be mistaken for blepharitis, or dirt on the lashes. The use of a mild mercurial ointment, such as that mentioned above, will soon kill the pediculi.

Hordeolum, or **stye**, is a circumscribed hard

swelling at the outer edge of the margin of the lid, due to a suppurative inflammation of one of the sebaceous glands at the roots of the lashes. There is considerable pain at first, and marked swelling from infiltration of the adjacent loose tissue of the lid. The most severe cases are of the nature of boils; in these the pain is very acute, and there is often considerable chemosis of the conjunctiva.

Treatment.—In an early stage, touching the part with nitrate of silver, pulling out the corresponding eyelash, and using lead lotion, often cut short the inflammation. Later on, warm applications are useful in soothing the pain and in hastening the suppurative process. When pus has formed it should be evacuated. General treatment is often indicated by the condition of the patient, mild purgatives, iron, and nitro-hydrochloric acid being frequently serviceable. Some young adults are particularly subject to styes occurring in successive crops, and the local treatment of most service in such cases is the use of an eye douche, with lead lotion. Styes are sometimes associated with an error of refraction, which should be corrected by the necessary glasses. At other times they are dependent on some defect in the general health, or on local irritation, as from blepharitis.

Distichiasis and **trichiasis** are terms used to signify different forms of displacement of the eyelashes produced by disease. In the former condition they are disposed in a more or less complete double row, while in the latter they are obliquely placed and often stunted; in both affections some of the displaced lashes rub against the cornea and thus set up irritation, sometimes leading to pannus and even ulceration. The usual causes of trichiasis are blepharitis and trachoma.

Treatment. — Temporary relief can always be afforded by epilation of the misplaced lashes. The

more radical operations consist either in destroying the cilia at fault or in giving them a new position. If there be only one or two lashes actually rubbing on the cornea, we may destroy their follicles by electrolysis. In more severe cases we may remove all the offending lashes and their bulbs by judicious excision of part of the lid margin. The number of methods that have been devised with the object of transplanting the misplaced lashes outwards, suggests the unsatisfactory nature of the results usually obtained. For an account of these operations the reader must be referred to special text-books on ophthalmic surgery.

Ankylo-blepharon, or union of the edges of the upper and lower lids, may be congenital, but generally arises from injuries (wounds or burns) or from ulceration. It is rarely complete. Division of the adhesions with scissors, and attention for a few days so as to prevent reunion, will generally effect a cure.

Entropion, or inversion of the lid margin, may affect either the upper or lower eyelid, but its nature usually differs in the two cases. It always causes much discomfort from the rubbing of the lashes against the cornea. Entropion of the lower lid generally occurs in old people, and is then due to a spastic contraction of the palpebral fibres of the orbicularis muscle in association with loose senile tissues. It may be relieved by excision of a strip of skin and orbicularis along the whole length of the lid, a little below its margin; sutures may or may not be employed.

We also occasionally get a spasmodic entropion of the lower lid from the prolonged use of bandages, as after cataract extraction. Generally, repeatedly brushing a little collodion outside the lid, a little below the lashes, is sufficient to relieve it, and in any case it soon disappears on discontinuing the use of the bandage. Entropion of the upper lid is usually organic, due to a cicatricial contraction of the

conjunctiva and inversion of the tarsus from burns or old trachoma. Relief can be obtained by radical removal of all the lashes, or by cutting or grooving the "cartilage" as in Burow's and Streatfeild's operations.

Ectropion, or eversion of the lid margin, may be caused by chronic marginal blepharitis, or by relaxed tissues in old age, or, again, by cicatricial contraction (as from burns or wounds, or from abscesses in caries near the orbital margin); or it may be due to a rapid hypertrophy of conjunctiva, as sometimes occurs in purulent ophthalmia. The lower lid is most frequently affected. This condition often produces much deformity, the conjunctiva is usually inflamed, and the eversion of the puncta causes the tears to flow over the cheek.

Treatment.—In the non-cicatricial cases we can (*a*) remove a horizontal strip of the everted conjunctiva and trust to the subsequent contraction drawing the lid into position; or (*b*) we may shorten the lid by removing a V-shaped piece of its entire thickness and bringing the edges together with sutures or a hare-lip pin. Cicatricial ectropion may affect either lid, and is often only partial. The remedial operation necessary must therefore be determined by the particular case, but the method most frequently useful in ectropion of the lower lid is that known as the V-Y operation.

Blepharospasm is a spasmodic contraction of the orbicularis muscle, usually a reflex result of irritation of the fifth nerve. It may occur from a foreign body in the eye, a phlyctenule, etc., or from caries of the teeth. In other cases there is pain or pressure over the supra-orbital or other branch of the fifth, while occasionally it is met with in weak hysterical subjects without any evident local cause.

The *treatment* must be determined by the cause.

In cases dependent on ocular conditions any foreign body present must be removed, and in phlyctenules great relief is afforded by the use of cocaine and atropine. Counter-irritation by blister or seton, and the cold face-douche are also often of great service. In severe cases that do not yield to other treatment canthoplasty is useful, the external canthus being divided with scissors, and the adjacent conjunctiva united by suture with the apex of the incision.

Ptosis, or drooping of the upper eyelid, may be mechanical, congenital, or paralytic. The latter form will be considered later. Ptosis may be said to be mechanical when it occurs in association with a shrunken globe or empty socket; or, again, in trachoma, where it is due to relaxation of the upper conjunctival fold and increased difficulty of elevation of the lid from its greater weight. The congenital form is often unilateral and varies in degree. It is said to be due to imperfect development of the levator muscle. In these latter cases the appearance may be improved by the removal of an oval piece of skin from the upper lid, so as to cause the shortening desired; but care must be taken not to leave the cornea permanently exposed by removing too much.

Certain other congenital anomalies are to be met with in the eyelids, and may be mentioned here. **Coloboma** appears as a wedge-shaped fissure, and is usually in the upper lid. The treatment consists in paring the edges and uniting them with sutures. In very rare cases the lids are completely absent. **Epicanthus** consists in a fold of skin passing from the side of the nose to the inner end of the eyebrow and concealing the inner canthus. It commonly disappears as the bridge of the nose is developed; but should it not do so the deformity may be removed by excising a vertical elliptical fold of skin from the upper part of the nose.

Chalazion, or **Meibomian cyst**, generally appears as a hard, round, painless tumour in the substance of the lid, about the size of a split pea, and its position is recognised on everting the lid by a greyish semitranslucent patch in an area of increased conjunctival vascularity. It is due partly to an hypertrophy of the Meibomian gland, partly to retention of its secretion and a chronic inflammation of the surrounding tissues. Occasionally it inflames acutely, and may then point cutaneously. Where possible it is always best to open it by a crucial conjunctival incision and remove all the contents with a scoop. They often occur in crops, and, like styes, are especially frequent in young adults.

The other **tumours** which are not infrequently found on the eyelid are milium, molluscum contagiosum, xanthelasma, and nævus. Their character and appropriate treatment are the same as when they occur in other situations, and do not demand further description here. In this region we may also get congenital dermoid tumours, warts, fatty tumours, and more rarely sarcoma and epithelioma. The eyelid is a favourite situation for rodent ulcer, while not infrequently we also find here primary and tertiary syphilitic sores and lupus.

Diseases of the Lacrymal Apparatus.

The lacrymal gland is rarely acutely inflamed. We then find localised symptoms of inflammation, the pain often very severe, and pus generally soon forms. It should be evacuated by early incision, as fistula may be the result when the pus is allowed to find its own way out.

Chronic inflammation of the lacrymal gland is more commonly met with, and is recognised by a circumscribed hard swelling in the upper outer part of the orbit, the enlargement being visible in

this part of the conjunctival fornix on everting the upper lid. We should try to produce absorption by local application of iodine or mercurial ointments. If pus forms it is to be evacuated as in acute cases. Very rarely we get a blueish translucent swelling in the same position, viz. up and out, a retention cyst in connection with the gland ducts (*dacryops*). A small seton placed and tied loosely in the anterior wall of the cyst, and allowed to ulcerate through, is a good method of treating this affection.

The **tumours** most liable to occur in the gland itself are cysts and sarcomata. When necessary the gland can be extirpated through an incision at the outer orbital margin above.

Epiphora.—In by far the greater number of cases of lacrymal disorder the drainage of the tears is defective, in consequence of which they run over the cheek, and we get the condition known as epiphora, stillicidium lacrimarum, or "watery eye." In such cases it is well always systematically to examine each part of the drainage system in the natural order of the passages from above downwards.

First, then, one of the *puncta* may be at fault, (*a*) from displacement, as in ectropion; or (*b*) it may be obstructed by the presence of a foreign body, *e.g.* an eyelash; or, again, (*c*) the puncta may be narrowed, sometimes even quite occluded, as a congenital malformation or as the result of old inflammation.

Next, the *canaliculus* may be obstructed by a chalky concretion or by a fungoid growth (leptothrix); or, again, its calibre may be narrowed, either from swelling of its mucous membrane, as in chronic blepharitis, or from cicatricial contraction, the result of a former inflammation. The most common position of stricture is just at its entrance into the sac.

The *sac* is subject to a chronic form of blenorrhœa and to acute inflammation. The former

condition is generally either the result of extension of inflammation from the conjunctiva or from the Schneiderian membrane, or it begins as a simple distension of the sac, due to stricture of the nasal duct below. The increased secretion of mucus from its thickened walls soon bulges the sac, and we find a swelling at the inner canthus which can generally be dispersed by pressure (*mucocele*). The contents can thus usually be forced backwards through the canaliculi, and are either clear, or turbid from admixture of pus.

Acute dacryocystitis, or lacrymal abscess, is generally the result of suppuration of a mucocele. There is brawny swelling and redness of all the adjacent part of the face, often extending to the bridge of the nose and half across the cheek; but its most prominent part corresponds to the position of the sac, where the shining red skin seems ready to burst. There is much pain, and considerable general disturbance. If left to itself the pus finds its way through the skin over the sac, but often burrows for a considerable distance before doing so, thus leaving a large ragged sore; the cicatrix left is always a source of deformity, and often we get a troublesome *fistula* in addition.

Stricture of the nasal duct may affect any part of it, but most commonly occurs just below the sac. It may be caused by a uniform circumscribed, or by a valvular swelling of the mucous membrane, by fibrous contraction of the submucous tissue, or by bony outgrowths. The etiology of the affection is obscure, but some cases can be traced to a syphilitic or strumous periostitis, or necrosis, and others to an extension of inflammation from the nasal mucous membrane.

Treatment.—Foreign bodies in the puncta or canaliculi must be removed, the latter being slit up if necessary. A narrowed punctum may be dilated by

a fine conical sound, or enlarged by incision. In epiphora from ectropion the canaliculus should be slit along its entire length, and the same treatment must be followed in stricture of the canaliculus. In all cases of mucocele and stricture of the nasal duct the upper or lower canaliculus is to be divided with a Weber's knife, and a probe passed. The probing should be repeated in a few days, and the interval gradually increased to a week or month as the case improves. The probe used should be fairly large if it will pass without force, a convenient size being No. 5 or 6, of the bulbous-ended kind known as Couper's. Washing out the sac and duct with boracic acid lotion is also useful, and a weak astringent should be ordered for the conjunctiva. In cases of lacrymal abscess, when still possible, the canaliculus should be slit and the knife passed down the duct so as to divide the anterior wall of the sac. Warm lead lotion is a good application afterwards. If the case be far advanced and pus already pointing, an incision should be made into the sac with a Beer's knife, and warm applications used; when the swelling has somewhat subsided the canaliculus is to be slit and the duct probed.

Diseases of the Conjunctiva.

The conjunctiva is subject to inflammation of different forms and of varied degrees of severity, to all of which the term "ophthalmia" is often applied. While usually the whole membrane participates, certain kinds of conjunctivitis are localised, at least at first.

Simple catarrhal conjunctivitis.—*Symptoms.* The whole conjunctiva is much congested, often showing patches of ecchymosis; there is considerable mucc-purulent discharge. The lids are somewhat swollen, soft, and discoloured, and on first waking from sleep their edges are glued together. Occasionally in children an easily detached, sharply limited

membrane is formed on the palpebral conjunctiva, to be carefully distinguished from that found in the diphtheritic form. The disease runs its course in from eight to fourteen days, and nearly always attacks both eyes. Corneal affections are rare. The patient complains of a burning, gritty sensation, aggravated at night and on exposure to light.

Causes.—It is exceedingly contagious, and is very apt to spread when once introduced into a household or school. It is liable to occur at all seasons of the year, but is especially common in early summer and late autumn. Its etiology is obscure; sometimes it seems traceable to a sudden change of temperature, as on coming into an overheated room from the cold outer air.

The *treatment* consists in using a cold astringent lotion (3 grains of alum or 1 grain of sulphate of zinc to 1 oz. of water) several times daily, and in applying vaseline to the edges of the lids at bed time, so as to prevent gumming.

Purulent ophthalmia (conjunctival blenorrhœa).—At first the subjective *symptoms* are like those in the catarrhal form (sensations of burning and grittiness), but soon there is generally severe pain in and over the eye, becoming less as the discharge becomes more profuse. The lids are swollen, red, and tense, the upper being also much elongated, so that in severe cases it cannot be fully everted nor the eye fully exposed. The entire conjunctiva, both palpebral and ocular, is much swollen and injected, the latter being frequently chemosed so as to project over the corneal margin. The secretion is at first watery, soon becomes opaque and whey-like, and is finally thick, yellow, and purulent.

Course and complications.—The discharge lessens spontaneously in the course of a few weeks, and there is not much tendency to connective tissue development. The palpebral conjunctiva often remains for

some time greatly thickened, and its surface covered with closely placed prominent granulations. Except in the most severe cases, the swelling and conjunctival injection disappear, and the secretion ceases in about three weeks under treatment, and the lids gradually recover their original smooth mucous lining. Where the chemosis is extreme we are apt to get corneal complications from strangulation of the marginal corneal vessels. Sometimes there is a slight diffuse haze of the entire cornea, but this is not so dangerous as a localised purulent infiltration. The latter ulcerates and often leads to perforation, and sometimes to subsequent panophthalmitis. Indeed, from the nature of the discharge, any loss of corneal epithelium is highly dangerous, and we must be exceedingly careful to avoid causing an abrasion in our efforts to evert the lids, and in our use of the brush or mitigated stick. Pathologically, we find in the acute stage great hyperæmia of the conjunctiva, with increase of its epithelium and hypertrophy of papillæ. Lymphoid cells occur diffusely both in and beneath the epithelium.

Causes.—Purulent ophthalmia results in some persons (as in subjects of chronic trachoma) from the contagion of an ordinary catarrhal conjunctivitis, but the two best marked forms of the affection are gonorrhœal ophthalmia and ophthalmia neonatorum.

(*a*) **Gonorrhœal ophthalmia** is due to inoculation with discharge from another similar case, or from a urethral gonorrhœa. The patients are generally young male adults. One eye only is affected at first, but the other runs great risk of infection. The symptoms are usually severe, and the condition is always a grave one, requiring every attention.

Treatment.—If one eye has escaped infection until the patient comes under observation our first aim is to protect this sound eye efficiently. This can be done by putting a pad of dry boracic acid wool over

the closed lids, and covering its entire surface and sealing its edges with collodion. This must be removed at least once a day for purposes of examination and cleansing, and a fresh pad is to be carefully reapplied. A more convenient method of protection is by the use of Buller's shield, consisting of a watch-glass inserted between two squares of indiarubber plaister, each of which has a large round hole in its centre so that the watch-glass remains uncovered except just round its edge. The double square thus prepared should be of such a size that when applied the watch-glass is opposite the eye, the upper edge of the square just above the eyebrow, the inner along the nasal bridge, the lower at least one inch below the edge of the lower lid, and the outer beyond the external orbital margin. All these edges, except the lower part of the outer, are then fixed securely in position with strips of strong adhesive plaister; through the watch-glass the eye can be kept under observation, and the patient can see to feed himself, etc.* The patient should be put to bed, an iced astringent lotion (four grains of alum or one grain of sulphate of zinc to the ounce of water) kept constantly applied over the lids of the inflamed eye, and a solution of chloride of zinc (two grains to the ounce) dropped into the eye three to six times a day, the frequency varying according to the amount and thickness of the discharge. The eye is also to be washed frequently with a cold astringent lotion, and as soon as the discharge becomes thick the everted lids should be painted once daily with a solution of nitrate of silver (twenty grains to the ounce). If the lids are very tense and painful, two or three leeches to the temple are beneficial. Sometimes it is impossible to evert the upper lid thoroughly: we must then cut through the external

* It is well to have these prepared beforehand and ready for use when required.

canthus with scissors, the direction of the wound being a continuation of the curve of the outer end of the lower lid. If the secretion collects much under the lids, the conjunctival sac should be syringed out with cold water two or three times daily; vaseline applied to the edges of the lids prevents gumming during sleep. On the appearance of localised corneal haze, with or without ulceration, the iced astringent compress must be discontinued, cold or even hot poppy lotion being used in its stead, and solution of sulphate of eserine (two grains to the ounce) dropped into the eye six times daily. The brushing of the lids should be continued, but we must be very careful in everting them, lest we cause rupture of the affected corneal tissue. The chloride of zinc drops may be discontinued, or a weaker solution employed, but they do not cause much irritation even in cases of deep ulceration. Slitting the conjunctiva radially with scissors when greatly chemosed is to be recommended, as it relieves the tendency to strangulation. The patient should get good diet, with tonics when considered necessary, and any urethral discharge must be treated locally. A mercurial purge should be given if the bowels are constipated at first. When the conjunctival discharge has nearly ceased the lids may only be brushed once every second or third day, and this treatment gradually discontinued.

(*b*) **Ophthalmia neonatorum.**—This is probably always caused by inoculation with leucorrhœal or gonorrhœal discharge during the passage of the head through the vagina. It is usually first observed about three days after birth, and varies much in severity in different cases according to the character of the infecting secretion, but is seldom so severe as the gonorrhœal ophthalmia of adults.

Treatment.—Both eyes are generally affected, but if one has hitherto escaped and the other be severely

inflamed, a protective of cotton wool may be applied as directed above. The affected eye is to be bathed frequently with cold astringents (alum or sulphate of zinc), the conjunctival sac thoroughly syringed out several times daily, and vaseline applied to the edges of the lids. If there is much discharge, chloride of zinc drops should be used four times a day, and in all cases, except the very mildest, the lids are to be brushed daily by the surgeon with solution of nitrate of silver. Peripheral ulcers of the cornea should be treated with eserine, as has been recommended in gonorrhœal ophthalmia, but in central ulceration atropine is preferable. Much attention has been recently drawn to the necessity of prophylactic measures for the prevention of this disease. It is recommended that the vagina be carefully disinfected before the birth, and that the face and eyes of the newly-born child be thoroughly cleansed with some simple antiseptic solution.

Granular ophthalmia or **trachoma.**—*Symptoms.* The form of this disease most commonly met with in this country is a *chronic* one, characterised by thickening and vascularity of the conjunctiva, and by the presence of round, semitranslucent, pale prominences on the inner surface of the lids. From their resemblance to small grains of boiled sago these prominences are often called "the sago grain granulations." At first they occur principally on the lower retro-tarsal fold of conjunctiva, spreading gradually to the same position above, and finally affecting the entire lid surface. The ocular conjunctiva often participates in the vascularity, and small granulations may even occur in it. We often get vascularity and cloudiness of the upper part of the cornea (*pannus*), the vessels here lying immediately beneath the epithelium; this condition sometimes extends over the entire cornea. Ulcers are also apt

to form on the cornea, especially when there are inverted lashes. There is no tendency to spontaneous cure, and a long continuance of the chronic changes generally leads to entropion, trichiasis, and often corneal mischief as just mentioned.

Apart from direct infection by the secretion from another such case, the chief *causes* seem to be prolonged exposure to a damp atmosphere and bad ventilation, children being most apt to suffer. Certain races, *e.g.* the Irish and Jews, seem specially liable to it.

Pathology.—The granulations consist principally of lymph cells superficially, with more and more connective tissue towards the base. As the cells are gradually transformed into connective tissue, so we get finally a cicatrix at the seat of the granulation. The submucous tissue and tarsus are likewise at first infiltrated with lymph cells, so that here, too, we ultimately get connective tissue contractions, the "cartilage" also undergoing fatty degeneration. Pannus is said to be mainly due to the irritation produced by the granulations of the upper lid constantly rubbing against the corneal surface on every lid movement, but possibly a more correct explanation would be that the general conjunctival infiltration with lymph cells extends hither, and, on becoming organised, forms new vascular tissue.

In the *acute* form of the disease the local appearances are those of a severe conjunctivitis, with development of the characteristic granulations, but often without much purulent discharge. Such an attack may lead to the chronic form of trachoma, but sometimes it is self-curative from the very violence of the inflammation destroying the granulations. Cases of chronic trachoma are liable to severe acute ophthalmia from comparatively slight exciting causes, and the discharge from all such cases is highly infective, often communicating the same form of disease.

Treatment.—In acute trachoma we should first use mild lotions (*e.g.* boracic acid 10 gr. to the ounce of water), but, if there be much purulent discharge later, we must brush the lids with solution of nitrate of silver. Chronic granulations are best treated by touching the everted lids with the mitigated nitrate of silver stick (1 of nitrate of silver and 2 of nitrate of potash), and then washing them with water. This should be repeated twice a week, or oftener, according to the severity of the case, and a mild astringent lotion used frequently by the patient. Single granulations may be destroyed by the actual cautery. The corneal ulcers, entropion, or trichiasis, demand the treatment proper for these affections; if there be photophobia, dark glasses are useful. The ordinary partial (upper) pannus usually disappears as the condition of the lids improves. Severe total pannus is much relieved by the excision of a strip of conjunctiva and subconjunctival tissue of about two lines in breadth from immediately round the cornea (*peri-otomy*). Benefit is also sometimes obtained in suitable cases by inoculation with pus from a mild case of ophthalmia neonatorum. Recently an infusion of jequirity seeds has been used, the purulent ophthalmia so produced often giving good results.*

Diphtheritic ophthalmia is a very serious disease, happily rare in this country. *Symptoms.*—At first the conjunctiva in its entire thickness is infiltrated with a firm fibrinous exudation, rendering the lid hard and stiff, and patches of the mucous surface are smooth, firm, and of a light grey colour. The existence of the exudation leads to pressure on the vessels, and the conjunctiva is found pale and almost

* About 45 grains of the decorticised seeds are macerated for twenty-four hours in half-a-pint of cold water, and a little of the fresh infusion applied to the conjunctiva twice daily for two or three days.

bloodless on tearing away a piece of the superficial layer. The nutrition of the cornea is necessarily greatly interfered with, and sloughing often occurs. When this stage has lasted about a week, the infiltration breaks down, and we get a free purulent discharge with red prominent granulations. Finally, we may get symblepharon from loss of large patches of conjunctiva and resulting cicatricial changes.

Causes.—It often occurs in epidemic form, chiefly in spring and autumn, and usually attacks young children from two to six years old. It may be communicated by direct transplantation of membrane, but in predisposed individuals a purulent ophthalmia may take on this type. It is more frequently a precursor of, than secondary to, general diphtheria.

Treatment.—Protect the sound eye by a pad of wool as previously described. In the first stage we must avoid using strong astringents, especially nitrate of silver, and trust to mild lotions (*e.g.* boracic acid or quinine) and atropine drops. Both ice and hot fomentations have been recommended by different surgeons. Scarifying the conjunctiva and applying a weak yellow oxide of mercury ointment have also proved useful. The patient's strength must be supported by nutritious food.

Besides the above-mentioned more severe and definite forms of conjunctivitis we frequently get *slight cases* due to the patient's occupation or surroundings. Thus dust of all kinds, smoke, or irritating vapours are apt to cause a chronic form of conjunctivitis, and not infrequently it is associated with some error of refraction. In the former cases sulphate of zinc lotion (one-half to two grains to the ounce of water) should be used and the cause removed as much as possible, glasses being ordered where required. Sometimes on everting the lids we find small, gritty, calcareous particles projecting from the

saccules of some of the Meibomian glands: these should be picked out with the point of a broad needle. Old people often have a troublesome conjunctivitis in the lower lids, commonly associated with slight ectropion; much relief is obtained from lightly touching the inflamed surface once daily with sulphate of copper. Instillation of atropine sometimes produces severe irritation of both surfaces of the lids, and in such cases if a mydriatic must be used, daturine or duboisine is generally much less irritant. Eserine also frequently produces a chronic conjunctivitis when used for some time. This unpleasant effect may often be avoided, in the case of all these applications, by dissolving the salt in a strong solution of boracic acid and adding about one per cent. of hydrochlorate of cocaine.

Subconjunctival ecchymoses may occur during straining, as in whooping cough, or spontaneously without apparent cause. They undergo gradual absorption, and are of no local importance.

Xerophthalmos is a term applied to a condition of the conjunctiva where its surface is dry and lustreless. Sometimes it exists with almost complete obliteration of both upper and lower culs-de-sac, and may then be due to old diphtheritic ophthalmia or lime-burns, or possibly to a succession of attacks of pemphigus. Sometimes the patch is only epithelial, and confined to an area near the outer and inner corneal margins. This form occasionally occurs in schools or other public institutions, and is associated with night-blindness and scurvy.

Treatment.—The epithelial cases are to be treated through the general health; good diet with vegetables, fresh air, etc., being most important. The parenchymatous forms can only be treated with palliatives, a lotion containing milk, glycerine, and bicarbonate of soda relieving the symptoms somewhat.

Symblepharon, or adhesion of the palpebral and ocular conjunctiva, is usually the result of burns with lime or hot metal. When its extent is such as to obscure vision or limit ocular movement, an operation may be tried for its relief. When partial and narrow, it will be sufficient to strangulate it by a tight ligature. Those of larger size are to be carefully dissected off the eye-ball, and the resulting gap filled in as well as possible by flaps of neighbouring conjunctiva, or by a piece of transplanted mucous membrane from the lip.

Pterygium is a triangular, vascular patch of thickened conjunctiva, its apex usually encroaching on the cornea from the inner or outer side. The growth is generally commenced by an adhesion of conjunctiva to a marginal corneal ulcer. If thought necessary, its apex may be detached from the cornea with a scalpel, the tumour dissected up to near its base, and then transplanted into a gap prepared for it below the cornea.

Lupus sometimes occurs on the palpebral conjunctiva, and is then usually associated with lupus of the skin or mouth. The affected patch of conjunctiva is very vascular, and is covered with small, soft, dark-red nodular outgrowths. Scraping with a sharp spoon is the best treatment.

A **pinguecula** is a small yellowish thickening of conjunctiva near the outer or inner edge of the cornea, common in old people; it contains no fat as the name would imply. It is of no importance, but may be snipped off if desired.

The other **tumours** of the conjunctiva (dermoid, cystic, malignant, fatty) are comparatively rare, and the reader must be referred to some of the larger text-books on eye diseases for their description.

Phlyctenular Affections of the Eye.

These affections are much most frequently met with in young people between the ages of three and twelve years, and usually in association with the strumous constitution. The attacks tend to recur during early life, such repetition being easily induced by any slight irritation of the eye.

Varieties and symptoms.—Either the ocular conjunctiva or cornea may be the seat of the phlyctenule. When situated on the conjunctiva quite away from the cornea, it appears at first as a papule or pustule about two mm. in diameter, surrounded by a localised patch of injection; this soon breaks down, and we have a flat whitish ulcer. There may be one or several such pustules, but they seldom cause much photophobia, pain, or lacrymation, and are generally soon amenable to treatment. Sometimes, however, especially when near the corneal margin, the ulcer formed may run on to the cornea, and travel towards, or even across, its centre. In such cases the ulcer advances slowly in the form of a small infiltrated crescent with its convexity forwards, and with a vascular leash running to its concavity over its recent track from the original starting point (Fig. 119). There is generally much blepharospasm during the attack. Very rarely a marginal pustule, instead of spreading superficially, leads to a perforating ulcer at the corneal edge. Phlyctenules at, or just within, the margin are usually small in size and multiple. Sometimes the entire corneal border all round is slightly swollen and

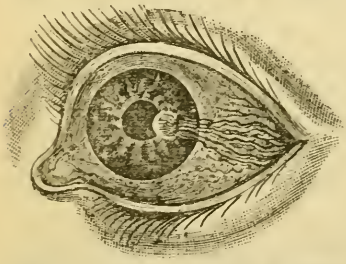

Fig. 119.—Vascular phlyctenular Ulcer of Cornea. (After Travers.)

vascular, with minute phlyctenular elevations like fine sand-grains: the conjunctiva generally is usually injected in this form. More commonly, at one or more points of the corneal margin, we find a vascular elevation, with greyish summit, about the size of a turnip seed. In all such cases there is generally considerable photophobia, and there are often short relapses during treatment, but ultimately they as a rule do well. Occasionally, however, such phlyctenules cause troublesome ulceration, but not so commonly as those which are located quite within the corneal edge, and appear first as prominent greyish opacities about the size of a small pin's head. In these latter the blepharospasm, pain, and lacrymation are usually severe.

Treatment.—In the case of conjunctival pustules, and in other forms without photophobia or deep corneal ulceration, the dilute yellow oxide of mercury ointment (8 grains to the ounce of vaseline) is the most suitable local remedy. A small piece of this salve should be laid within the lower lid once or twice daily, the upper lid then gently rubbed over the eye-ball for a few minutes (with the finger placed on its skin surface), and the eye bathed with lukewarm water half an hour later, if irritation continues. Finely-powdered calomel dusted into the eye once daily may be substituted for the ointment. Where there is photophobia the patient should wear a large shade or goggles over both eyes, and atropine ointment (2 grains to the ounce of vaseline), or a mixture of equal parts of this and the dilute yellow oxide of mercury ointment, according to the severity of the symptoms, should be applied twice daily. In the vascular travelling ulcer the same local treatment is good, combined with a seton in the temple. Division of the leash of vessels at the corneal edge is also recommended. For the small, multiple, marginal phlyctenules with conjunctivitis, cold or lukewarm

boracic acid lotion should be used four times daily, and the atropine ointment put into the eye after each bathing. The measures useful in persistent blepharospasm have been already described under that heading. (*See* page 544.) Constitutional treatment must not be neglected. Good plain food (especially warm milk), with syrup of the iodide of iron, and cod-liver oil, are indicated, and the patient should get plenty of open-air exercise, with the eyes efficiently protected. As a rule such cases do not do well at the sea-side as long as there is much photophobia.

DISEASES OF THE CORNEA.

Keratitis.—There are several distinct forms of corneal inflammation, and each may present varying degrees of severity. The inflammation may be superficial or deep, circumscribed or diffuse, purulent or non-purulent. Before considering the different types of keratitis we may briefly regard the subject generally.

The **subjective symptoms** that are usually associated with corneal inflammation are pain, photophobia, lacrymation, and impairment of vision. The *pain* is generally in and around the eye, but sometimes may be also referred to the distribution of the fifth nerve in the face and temple, as where there is associated iritis. The *photophobia* is really, more properly speaking, a reflex blepharospasm, and, like the *lacrymation*, is due to irritation of the sensory fifth nerve branches in the cornea. These latter symptoms are usually most severe in young patients and where the corneal affection is superficial. The *impairment of vision* varies directly with the density of the haze produced, and its more or less central position. *Locally* we get congestion and loss of corneal transparency. Not infrequently we have iritis also, and even where this does not exist the pupil is often

small, probably a "congestion miosis." The nature of the *loss of transparency* differs according to the corneal layer involved and the character of the

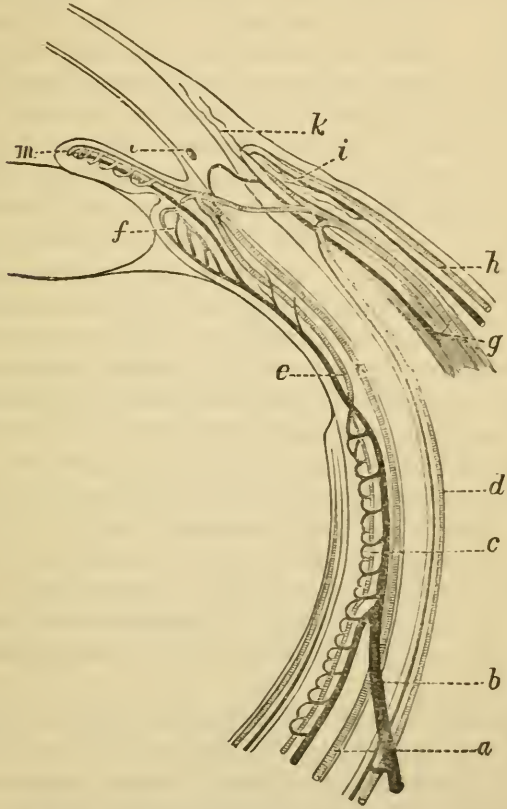

Fig. 120.—Vascular Supply of the Eye-ball.

a, Long posterior ciliary artery; *b*, vena vorticosa; *c*, chorio-capillaris; *d*, episcleral branches; *e*, recurrent choroidal artery; *f*, vessels of ciliary processes; *g*, anterior ciliary arteries and veins; *h*, posterior conjunctival vessels; *i*, anterior conjunctival vessels; *k*, marginal loop-plexus of cornea; *l*, canal of Schlemm; *m*, vessels of iris. (After Leber. Diagrammatic.)

inflammation. When the anterior epithelium is affected the surface looks steamy and finely pitted. Chronic interstitial inflammation gives rise to an

opalescent haze, the anterior epithelium sometimes remaining sound. A yellow opacity results from the presence of pus between the layers. Minute round white dots on the posterior surface are found in inflammation of the posterior epithelium (keratitis punctata). The *congestion* may be deep, appearing simply as a pink or lilac circumcorneal zone, *e.g.* in an early stage of keratitis, in many cases of corneal ulcer, etc., and due to injection of the episcleral branches of the anterior ciliary arteries. Or we have a salmon-coloured patch over part of the cornea from formation of new vessels in its true stroma, as in interstitial keratitis. Again, we may get a superficial vascular mound encroaching on the corneal edge at one or two spots, or all round, as in many cases of peripheral ulcer, and especially in miliary phlyctenules, and due to injection of the marginal loop-plexus (Fig. 120). Pannus we have already mentioned when speaking of trachoma; the new vessels under the epithelium are in connection with the conjunctival vessels. Pannus may also, less commonly, result from trichiasis, entropion, phlyctenular keratitis, chronic blenorrhœa, and may occur during the healing process in corneal ulcers. Sometimes we also get considerable conjunctival injection in association with keratitis.

Causes.—Local injury, malnutrition (local or general), and constitutional disease. It may likewise occur as part of a more general ocular inflammation. As examples of corneal inflammation produced by *local injury*, we have ulceration from a foreign body or abrasion, and suppurative interstitial keratitis after cataract extraction. As forms resulting from *local malnutrition* we may instance the severe keratitis met with in purulent and diphtheritic ophthalmia, where infiltration of the conjunctiva and subconjunctival tissue has led to strangulation of

vessels round the corneal margin; also possibly the ulceration often found in cases of herpes frontalis. *General malnutrition*, as a result of over-lactation, insufficient food, etc., is responsible for many cases of ulceration, and for the keratomalakia met with occasionally in puny, ill-thriven infants. The best marked *constitutional* types of corneal inflammation are the interstitial keratitis of congenital syphilitics and the phlyctenular of strumous children. In sympathetic ophthalmitis, relapsing cyclitis, etc., the corneal affection is *part of a more general ocular inflammation.*

The **treatment** will be considered more particularly later; but we may say here that hot fomentations are nearly always indicated, and that atropine is good except where we have increased tension.

Results.—There is always more or less opacity, which may or may not ultimately clear up. Superficial nebulæ and parenchymatous opacity from chronic interstitial keratitis are most likely to disappear, especially if the patient be young. Sometimes we get a staphylomatous bulging, as after perforating ulcer; in other cases the cornea flattens and shrinks after extensive loss of its substance.

Varieties of keratitis.—1. **Ulcers** of the cornea either commence with a loss of epithelium, or are formed by the breaking down of a circumscribed infiltration. If much purulent infiltration remains at the base and edges of the ulcer the healing process is generally less rapid and the tendency to perforation greater; some clear ulcers, however, heal very slowly. In purulent ulceration, or in cases of corneal ulcer complicated with iritis, we may get a deposit of pus in the lowest part of the anterior chamber (*hypopyon*). If this be quite fluid, its upper boundary shows a level surface, its plane altering fairly readily according to the position of the patient's head. If it be thick,

consisting of puro-lymph, the upper surface is more or less convex upwards, and it moves slowly and partially (if at all) on changes in position. The pus in hypopya may be derived from the cornea or iris; if from the cornea it may result from suppuration of its posterior epithelium, or may come from an abscess that has either burst through the posterior surface or that has gravitated interstitially and has filtered into the chamber through natural spaces, such as those of the ligamentum pectinatum iridis. To the gravitated deposit remaining between the corneal lamellæ the term *onyx* is applied. If the ulcer passes quite through the parenchymatous tissue the posterior elastic lamina bulges into the gap, constituting a hernia corneæ. On perforation occurring, the aqueous escapes, the pupil contracts, and the iris and lens lie against the posterior surface of the cornea, the iris often even prolapsing through the aperture; in such cases we occasionally get purulent inflammation of the iris, choroid, and vitreous, and ultimate loss of the eye. During the process of healing of a deep ulcer, superficial vessels are formed on the cornea running from the limbus, and the base of the ulcer loses its yellow colour. As a final result we get a clear facet, a nebula, or a more or less dense leucoma (permanent if from a deep ulcer); where perforation occurred we usually have an anterior synechia.

Forms and treatment.—Many distinct types of corneal ulcer* occur, but for practical purposes we may (with one exception, to be considered later) divide them into *superficial* and *deep*, *central* and *peripheral*, *clear* and *infiltrated*. Chronic clear superficial ulcers require local stimulation, as with the dilute oxide of mercury ointment or powdered calomel. Infiltrated ulcers are best treated with hot fomentations, applied

* For description and treatment of phlyctenular ulcers, *see* page 560.

every hour or so for 10 to 20 minutes at a time, and used as hot as can be tolerated; in the interval the eye should be covered with a firm pad of cotton wool. If the ulcer be central or painful, belladonna fomentation (ʒj of extract to the pint of water), or hot boracic acid lotion will be suitable, and atropine drops (4 gr. to the ounce) instilled four to six times daily. When in the periphery of the cornea, and especially where the tension of the globe is increased, the ulcer is best treated with eserine drops (2 to 4 gr. to the ounce), and hot boracic acid or poppy fomentation. In the case of deep ulcers with much purulent infiltration it is well, first of all, to scrape the base of the ulcer with a small sharp-edged spoon, so as to remove all the broken down corneal tissue, and afterwards to fill the cavity with powdered boracic acid; the hot fomentations and atropine or eserine drops should then be used. If the ulcer have all but perforated, and there be no hypopyon, we should prick the projecting posterior layer with a sharp needle. Whenever *hypopyon* accompanies purulent ulcer or corneal abscess, the most generally successful treatment consists in cutting right through the cornea with a narrow linear knife, the slit extending quite across the inflamed area and just into the sound tissue at each side; on completing the section the aqueous escapes and generally carries with it all, or some, of the hypopyon. Not infrequently a thick piece of puro-lymph sticks in the wound and can be easily withdrawn with forceps.

The exceptional form of ulcer above alluded to as demanding separate consideration is the *serpiginous* (ulcus serpens). It generally begins as a small, oval or round, superficial loss of substance, with slight opacity, usually near the centre of the cornea. At one or more points along its margin we find a white, cheesy-looking, crescentic infiltration. The ulcer spreads in the direction of the infiltrated crescents,

and may thus creep over the entire corneal surface, cicatrising at some places while extending at others, while it also often tends to affect the deeper layers. The symptoms are frequently severe, *i.e.* well-marked congestion and great pain. It is apt to become complicated with iritis and hypopyon, and sometimes perforation takes place. Persons advanced in years, and subjects of chronic dacryo-cystitis are liable to get this form of ulcer, often from a mere corneal abrasion. A fungoid growth (aspergillus) is said to be the active local cause of the ulceration. In an early stage the treatment should consist in hot fomentations frequently, atropine four times a day, and powdered iodoform dusted over the cornea twice daily. Some surgeons recommend touching the infiltrated edge with the actual or galvano-cautery. If perforation occur, atropine or eserine should be used according to its position, so as to prevent prolapse of iris as far as possible. In severe pain leeches to the temple relieve temporarily; but if it returns, and particularly if there is increased tension or hypopyon, corneal section is advisable. (*See* page 567.) If the hypopyon returns and the tension keeps high, iridectomy should be performed.

In all forms of corneal ulcer, but especially where there is photophobia, the eyes should be shaded from light. In every case the general health of the patient must be inquired into, and the diet and exercise regulated according to the indications. Tonics are often useful, quinine seeming to be so specially in purulent ulceration and abscess with hypopyon. Lead lotion should never be used where there is a corneal abrasion, as we are apt to get an opaque, white, sharply margined, insoluble opacity as the result. This lead deposit can be removed piecemeal with care, by means of a Beer's knife inserted below the edge of the flake.

2. **Abscess of the cornea.**—We get one or more circumscribed yellow, purulent infiltrations in the corneal substance, with circumcorneal injection and often with severe subjective symptoms. Their occurrence is often connected with a low state of health, as from over-lactation or after an exanthem; sometimes they are found with granular lids or purulent conjunctivitis. The abscess tends to burst anteriorly and form an ulcer; exceptionally it opens posteriorly. In all cases, except where there is trachoma or other form of conjunctivitis, the *treatment* should consist of hot fomentations and atropine. When of considerable size, say 2 mm. in diameter, and in all cases complicated by hypopyon, paracentesis through the floor of the abscess is indicated. When conjunctivitis is present cold applications are best, with atropine, and appropriate treatment of the palpebral conjunctiva.

3. **Keratitis punctata** is the term usually applied to cases where numerous round, opaque, whitish dots are found on Descemet's membrane, generally disposed in the form of a triangle on the lower part of the cornea with its apex central. There is nearly always iritis, and it is particularly common in sympathetic ophthalmitis. Sometimes in young (?) strumous adults it occurs without apparently any iritis, *i.e.* without discoloration, contraction of pupil, or posterior synechiæ; this form is often associated with a deep anterior chamber and increased tension, and the iritis present is not plastic. The condition just described is called *Descemetitis* by some, the term punctate keratitis being restricted to cases where whitish punctate infiltrations occur in the posterior part of the corneal stroma.

Treatment.—Hot fomentations and atropine are useful locally, the latter not increasing tension here. The cases are usually very tedious. The patient must

wear a shade or dark goggles, and have constitutional or other treatment according to the probable cause of the local affection.

4. **Diffuse interstitial keratitis** begins in the centre or near the edge of the cornea as an area of slight opacity; in the course of a few weeks it spreads gradually over the entire cornea, denser at

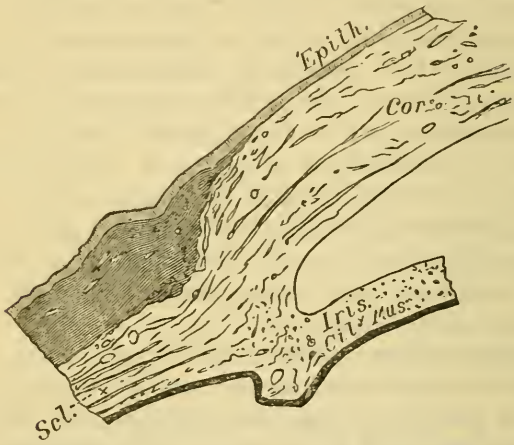

Fig. 121.—Thickening of Cornea and formation of Vessels in its Stroma in Interstitial Keratitis. Subconjunctival tissue thickened. (After Nettleship.)

some parts than at others. We find usually a patchy light red ("salmon-coloured") vascularity, commencing at the periphery and extending inwards towards the centre of the cornea (Fig. 121). There is circumcorneal congestion and a varying degree of photophobia; iritis frequently occurs. The attack lasts on an average from six to twelve months, and is almost always bilateral, but commonly with an interval of a few weeks between its onset in the two eyes. It generally occurs during second dentition, but it may exceptionally be met with in early childhood or as late as middle life. The infiltration is very rarely purulent, but in some cases it is exceedingly severe, causing corneal

shrinking. As a rule the opacity clears up wonderfully, the patient ultimately getting very good vision. In the great majority of cases we get a definite history of inherited syphilis, and very commonly we find other signs of the disease in the patient, *e.g.* the characteristic pegged or notched teeth, scarring at the angles of the mouth, deafness, etc.

Treatment.—Locally, atropine drops; if there be pain, hot fomentations and leeches to the temples. Internally, a mild course of mercury is advisable, with iron if there be anæmia; a pill (or powder) containing hydrargyrum cum cretâ, ferrum redactum āā gr. j, may be given three or four times daily, the effect on the gums being carefully watched.

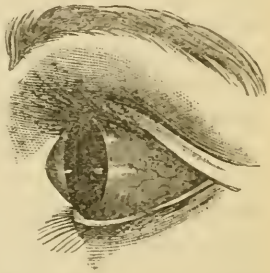

Fig. 122.—Conical Cornea. (After Mackenzie.)

Conical cornea usually begins shortly after puberty, and increases very gradually, sometimes becoming stationary spontaneously. It is most common in females. The apex of the cone corresponds to a point a little below the centre of the cornea, and it often becomes nebulous in advanced cases. The condition is best recognised on looking at the cornea sideways, but a prominent cone is easily seen in any position, and gives a glistening appearance, as if there were a tear in the eye (Fig. 122). The myopic astigmatism produced is irregular, and cannot be corrected by an ordinary glass, but vision may often be improved by wearing a disc with slit aperture, the exposed corneal meridian being corrected with its appropriate concave lens. When the cone is sharp-pointed or nebulous, removing a wedge-shaped piece, including the apex, produces the best result.

Tumours of the cornea are very rare as primary growths, and it is generally only affected in its superficial layers. Dermoid tumour, epithelioma, and sarcoma are the most frequent in occurrence.

Injuries.—*Foreign bodies* on or in the cornea are to be removed with a spud or bent needle; after this operation, and in cases of simple *abrasion*, the eye should be bandaged until the epithelium is restored. Cocaine is very serviceable where foreign bodies have to be picked out, the only disadvantage from its use in such cases being that it renders the cornea abnormally flaccid. Ordinary cleanly cut corneal wounds usually heal quickly. Where *prolapse of iris* has occurred, and the case is quite recent, we may try the effect of eserine, or atropine with cocaine, according to its position (the mydriatic where central, eserine where peripheral), so as to induce its retraction within the chamber; we should *never* use a spatula to push back the prolapsed iris. If the prolapse be of more than a few hours' standing it is best to seize it with iris forceps, pull it free, if possible, from the edges of the wound, and snip it off internal to the constricted portion. If it has existed too long to be freed in this manner, we must cut it off level with the cornea, or we may enlarge the original wound and remove a larger piece of iris, including its sphincter edge. In *burns* from lime, hot metals, etc., our prognosis should be guarded, as the cornea may remain fairly clear for some days after the injury, and yet the result prove ultimately unfavourable. In recent cases any remaining fragment of metal or other solid must be removed, and in the case of burns with acids or alkalies the conjunctival sac is to be thoroughly washed out with a mild solution of opposite reaction. Ice compresses should be applied in all cases of severe recent injury, and in corneal burns a drop of atropine and of castor oil are to be put inside the lid, thrice daily. When

keratitis results, hot fomentations, etc., must be used as recommended above.

Diseases of the Iris.

Iritis.—The *subjective* **symptoms** of acute iritis are pain, photophobia, lacrymation, and impairment of vision. The amount of *pain* varies much in different cases and at different times ; it is usually worst at night and during an early stage of the attack, and is most apt to be severe in the arthritic and the traumatic varieties. The first symptom of iritis is often an itching sensation down the side of the nose, and the pain is referred not only to the eye, but also frequently to the supra-orbital, temporal, and other branches of the fifth nerve. The *photophobia* and *lacrymation* are seldom so severe as in corneal affections, and are worst at an early stage of an acute attack. The *impairment of vision* is generally due to the opacity of the media (cornea, aqueous, pupillary area of anterior capsule, or rarely vitreous) ; sometimes also to hyperæmia of the optic disc and retina. The *local* symptoms are circumcorneal congestion, discoloration of iris and loss of its lustre, narrowness of pupil, slowness of pupillary reaction, and posterior synechiæ. The *circumcorneal congestion* occurs as a lilac-coloured zone, about two to four mm. wide; sometimes the anterior and posterior conjunctival vessels are also congested. *Discoloration.*—A blue or grey iris becomes greenish, and a brown becomes dark reddish-brown ; occasionally the change of colour is only partial. The discoloration, loss of lustre, narrow pupil, and sluggish action to light and mydriatics are all due to congestion, with effusion of lymph and serum into its substance. A large amount of solid exudation into the iris often occurs in syphilitic iritis, sometimes appearing as distinct yellow or rust-coloured nodules on its anterior surface. Sometimes we get *opacities in the aqueous humour* from pus or

blood corpuscles; their presence in suspension assists in producing an apparent discoloration of iris. When they form a deposit in the anterior chamber we get hypopyon or hyphæma. A large hypopyon is usually found in cases of iritis secondary to keratitis or purulent choroiditis. Hyphæma is commonly the result of wound of the iris, but sometimes occurs from a blow, or during whooping cough. Occasionally we get a round grey gelatinous mass in the anterior chamber from coagulation of the exudation, looking somewhat like a dislocated lens. *Posterior synechiæ* are the result of an exudation of lymph on the posterior surface of the iris, gumming it to the anterior lens capsule; they usually occur at the pupillary edge. They become readily visible on using atropine, the pupil dilating between the synechiæ, which now appear as pointed projections from the edge of the iris (Fig. 123). If no apparent change in the pupil take place on using atropine, the pupillary edge is adherent all round (*excluded pupil*), or the entire posterior surface of the iris is adherent (*total posterior synechia*). When much lymph is exuded it may cover the entire pupil, forming, when organised, a more or less dense whitish membrane (*occluded pupil*). In non-plastic inflammation no posterior synechiæ are formed. Not infrequently we get a punctate precipitate on Descemet's membrane, a secondary keratitis punctata. (*See* page 568.)

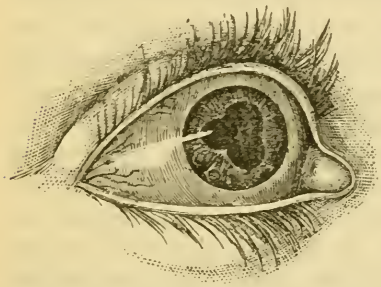

Fig. 123.—Posterior Synechiæ, the result of Iritis.

The most convenient classification of iritis is an etiological one, and we shall therefore consider at the same time its

Causes and varieties.—Iritis may arise from local injury or from constitutional disease; it may also be secondary to other inflammation in the same eye, or sympathetic from wound of the opposite eye.

Traumatic iritis is not only caused by injuries of the iris itself, but may follow any penetrating wound of the eye-ball, particularly in old people and where the lens has been wounded. Slighter forms of it often follow cataract extraction; sometimes after this operation the iritis is severe, and may be suppurative where there is purulent infiltration of the corneal wound. Occasionally superficial corneal wounds and direct blows on the eye are followed by iritis.

The *constitutional* causes of iritis are syphilis, rheumatism, gout, and possibly struma. *Syphilitic iritis* is acute, and usually symmetrical; it occurs in the secondary stage of the disease, either acquired or congenital. There is often much effusion of lymph, and occasionally vascular nodules of it project from the surface of the iris near the pupillary edge; when large, these may suppurate and cause hypopyon. *Rheumatic iritis* is recurrent, and both eyes usually suffer, but seldom both at once. The interval between the relapses may be many months. There is rarely much lymph effused, but the congestion and pain are often very severe. It sometimes accompanies gonorrhœal rheumatism. *Gouty iritis* resembles the rheumatic in its being recurrent, and in its affecting one eye at a time. It is sometimes very chronic and insidious, leading slowly to much contraction of pupil and impairment of vision without severe pain. *Struma* is said to be the cause of some cases of slight iritis, with keratitis punctata, occurring in young adults. *Secondary iritis* may result from continuity of structure in inflammations of the cornea (particularly when complicated with hypopyon), ciliary region, or choroid.

Sympathetic iritis and its peculiar symptoms will be considered later.

Results of iritis.—The adhesions are often persistent, but if due to freshly effused lymph they will nearly always, sooner or later, yield to atropine, often, however, leaving permanent dark spots of uveal pigment on the anterior surface of the lens capsule. When complete exclusion of the pupil occurs the body of the iris becomes bulged forward by the aqueous fluid between it and the lens capsule, so that the anterior chamber is shallow, except just over the pupil; in such a condition we are liable to get secondary glaucoma. In old-standing cases of chronic iritis with numerous posterior synechiæ, secondary cataractous changes often occur in the lens. When the pupil is occluded vision is always much interfered with, particularly, of course, if the membrane be dense, and in such cases also secondary glaucoma may follow.

Treatment.—Perfect rest of the eyes and the use of a shade or dark goggles must be insisted on till the attack has quite passed off. Locally, atropine drops (4 gr. to the ounce), one to be instilled from four to eight times daily, according to the severity of the attack; they are useful in often breaking down synechiæ already formed, and in preventing the formation of new adhesions, and they also diminish congestion and relieve pain. If the latter be very severe, two or three leeches should be applied to the temple, and the eye bathed frequently with hot belladonna lotion. A dry pad of cotton wool is to be worn over the eye and removed only when necessary for local applications. In syphilitic cases mercury in some form should be given to slight salivation, and continued cautiously till acute symptoms disappear. Salicylate of soda is worthy of trial in arthritic cases. The diet must be carefully regulated. In

severe recurrent iritis that does not yield to ordinary treatment, an iridectomy is sometimes followed by excellent results. In cases of recent injury where iritis is dreaded, ice compress continuously applied over the closed lids for twenty-four hours is valuable as a prophylactic measure. On the very first onset of the symptoms of iritis two or three leeches to the temple will often cut short the attack.

Iridodonesis, or tremulous iris, is generally due to loss of its posterior support from luxation or absence of the lens, or from fluidity of the vitreous. Sometimes the iris quivers slightly in a healthy eye, especially in myopia.

Fig. 124.—Coredialysis following a blow. (After Wardrop.)

Injuries of the iris.—(1) *Foreign bodies* which have penetrated the cornea and become fixed in the iris must be removed, along with the portion of iris implicated, by iridectomy.

(2) *Iridodialysis* (*coredialysis*), or separation of the iris from its ciliary attachment, sometimes results from a blow on the eye, and is usually accompanied by hyphæma (Fig. 124). When recent, the treatment should consist in ice compresses for twenty-four hours, followed by warm fomentations so as to favour removal of the blood clot.

Tumours of the iris may be solid or cystic. The *solid* tumours are tubercular, syphilitic, or sarcomatous. Where there is reason to suspect them to be tubercular or sarcomatous the affected piece of iris and the growth should be removed ; if this cannot be done effectually, the globe should be excised. In syphilitic cases specific treatment must be adopted. *Cysts* are

generally the result of injury, and should be removed, as they are liable to lead to secondary glaucoma.

Congenital anomalies. — *Coloboma* usually occurs below, or down and in, appearing as a gap in the iris like that left by an iridectomy. It is due to imperfect closure of the fœtal choroidal cleft. *Irideræmia* (absence of iris) is a rare condition, often associated with microphthalmos or other congenital ocular defect. *Persistent pupillary membrane* is usually only represented by traces, which appear as thin bands of iris tissue attached to the anterior surface of the iris, but not to the lens capsule.

Diseases of the Sclerotic and Ciliary Region.

Episcleritis appears as a swollen, congested, discoloured patch of considerable size in the ciliary region, the unaffected part of the globe usually remaining of normal colour. It is really a circumscribed inflammation of the sclerotic with effusion into the subconjunctival tissue over it, and congestion both of the deeper and of the conjunctival vessels. The colour is usually rusty or purplish-red. As a rule, the subjective *symptoms* are slight, but sometimes the pain is severe, and there is generally much tenderness on pressure over the affected part. It is most apt to begin in the outer ciliary region, but relapses are usual, fresh spots being attacked until often the entire ciliary area has suffered. It rarely occurs in both eyes at once, but the second eye is often attacked later. Its course is slow, the swelling reaching its height in two to three weeks, and then undergoing slow absorption; the middle of the formerly inflamed patch generally remains dusky. It is much most common in adults. *Causes.*—One form, rather more sharply limited than the usual one, is due to tertiary syphilis. In other cases rheumatism and anæmia seem to be predisposing causes; menstrual

disturbances are frequently associated with it in women. *Treatment.*—Rest, warm bathing, dilute yellow oxide of mercury ointment with atropine (with *massage*), and blisters to the temple are most serviceable. The medicinal treatment must be regulated by the history and condition of each individual case.

Sclero-kerato-iritis (*relapsing cyclitis, anterior sclero-choroiditis*) is the name applied to a disease in which a somewhat similar scleral swelling to that just described occurs, but here associated with peripheral corneal opacity and iritis. The swelling is slight, diffuse, and of a deep violet colour, occurring in one or more large patches, coming quite up to the corneal border. The subjective *symptoms* are usually severe. It is extremely tedious, and relapses are frequent, causing more and more corneal haze, and thinning, staining, and bulging of the ciliary region. It is most common in women about middle life, and is often associated with a family history of struma, or, according to some, of arthritic disease. The *treatment* is much the same as in the last affection, atropine being especially indicated here, and the use of dark glasses. Mercury with cod-liver oil and iron are useful. It is extremely intractable, and, when practicable, change to a warm, dry climate is advisable.

Cyclitis is rare as a primary affection, and would be recognised by deep circumcorneal injection, with tenderness on pressure on this region, and by opacities in the anterior part of the vitreous without visible iritis. The tension is often much reduced, but later on the eye may become glaucomatous from ultimate implication of the iris and posterior synechiæ. A chronic relapsing form of the affection, associated with irido-choroiditis and keratitis punctata, is occasionally met with in young people, and often with a history of inherited gout. In the less severe cases a good

result is generally obtained, the best *treatment* being rest, dark glasses, and atropine; and internally iron and quinine, with a mild mercurial course.

In **traumatic cyclitis** marked pain is an early symptom, along with the other signs mentioned above. The rest of the uveal tract (iris and choroid) are soon affected, and this form of inflammation is often a forerunner of sympathetic inflammation of the other eye. Sometimes the inflammation becomes purulent in type (*panophthalmitis*), and in such cases the liability to sympathetic disease seems decidedly less than in the plastic form, though the early excision generally practised in panophthalmitis may possibly account for this difference.

Wounds of the sclerotic.—There is generally simultaneous wound of some part of the uveal tract, and often of the retina, with loss of vitreous. Often we find hæmorrhage into the anterior chamber, or vitreous, or both. If the wound be quite behind the ciliary region, *i.e.* quite a quarter of an inch from the corneal margin, and recent, we should apply an ice compress, and trust to its healing. If it gape much, one or two fine stitches may be inserted, but care should be taken not to embrace the deeper layers of sclera in our suture, as then the choroid will almost certainly be included, and an irritable eye with uveitis may be left. When a foreign body is embedded in the anterior, but post-ciliary, part of the sclerotic, it must be removed, the wound being enlarged for this purpose if necessary. Where the ciliary region is deeply wounded stitches should never be used, and it is really safer in all such cases to excise the eye-ball at once. If the lens have escaped injury, however, and the case be quite recent, ice compress may be applied and the eye watched, and excision deferred till there be evident signs of cyclitis or marked sympathetic irritation.

Rupture of the sclerotic is not an uncommon

result of a direct blow on the eye, usually occurring a little outside, and concentric with, the corneal margin. The rent is generally large and involves all the tunics, we then may get escape of the lens and part of the vitreous, there is blood in both aqueous and vitreous chambers, the eye is soft, and vision is greatly reduced. The conjunctiva is the tunic most likely to remain unruptured, and then the lens may pass through the scleral rent and remain under the conjunctiva as a round, translucent tumour. In very severe cases of rupture immediate excision is best. In less severe cases, and especially when the conjunctiva has escaped untorn, we should apply ice compress and wait till the absorption of blood enables us to judge of the probable future usefulness of the eye. If it be decided to retain it, a subconjunctival dislocation of lens should be left until the scleral rent has healed, when it can easily be removed.

Primary tumours of the sclerotic are exceedingly rare; sarcoma and fibroma have been observed. It is often secondarily affected in the case of morbid growths of the choroid or retina.

Sympathetic Affections of the Eye.

The condition most liable to excite sympathetic disease is a plastic inflammation of the uveal tract (iris, ciliary region, choroid), usually the result of a wound involving the ciliary region. The eye injured or first inflamed is called the "exciting," the other the "sympathising" eye.

Sympathetic irritation.—The common symptoms are lacrymation, photophobia, and occasionally dimness of vision in the sympathising eye. It flushes on exposure to a bright light, especially if the exciting eye be also exposed or otherwise irritated. Sometimes pain is felt in the forehead or shooting across the root of the nose. The occasional dimness is

usually mainly due to a relaxation of the ciliary muscle rendering accommodation impossible, or sometimes possibly to a condition of spasm rendering distant objects indistinct. In such cases the pupil will be found to react well to light, but to be in a constant state of oscillation. Sometimes there seems to be a true temporary blindness, the nature of which is doubtful.

Treatment.—If the exciting eye be lost or manifestly a dangerous one, it must be excised without delay. If, however, it be uninflamed, its vision good, and the wound not such as is likely to lead to sympathetic inflammation, the patient should be kept at rest, dark goggles worn, and the condition watched for a few days. If the irritation persist or increase, it is advisable to excise, but even after excision the symptoms may not cease for a considerable time.

Sympathetic inflammation usually sets in a month or two after the injury, but it may appear as early as two weeks, or may be delayed for many years. It always attacks both eyes, but not necessarily with like severity. One of the earliest and most constant signs is the occurrence of keratitis punctata. In severe cases the iritic adhesions are rapidly formed, extensive and firm, and the iris itself is much thickened, with numerous large blood-vessels visible on its dulled surface. Eventually we get occluded pupil, increased tension, and secondary cataract. In the worst cases ciliary staphylomata form, and the globe finally shrinks. In the milder cases no synechiæ are formed, or they give way readily to atropine.

Treatment is too frequently of little avail after sympathetic ophthalmitis has begun. The exciting eye, if quite blind or practically useless, must be excised at once. If there be any hope of useful vision in it, however, it should be retained, as its removal will now do little or no good to the other, and it may

eventually be the better eye of the two. The sympathising eye, and the exciting eye if retained, must be covered with a black bandage and treated with atropine, leeching or blistering to the temple, and perfect rest in a dark room. In moderately severe cases, when the eye has become perfectly quiet (always at least a year after the beginning of the inflammation), an operation may restore some vision. Our great aim, however, must be to *prevent* this form of inflammation by early excision of lost dangerous eyes, whether blind from injury, or from past inflammation in which the iris or ciliary region has participated. We have already mentioned cases of injury where excision is advisable. (*See* also page 580.)

Diseases of the Lens.

Cataract, or opacity of the crystalline lens, may occur at any age, and may be partial or complete. An opacity in this situation looks white or light grey by reflected light (*e.g.* on focal illumination), and black by transmitted light, as when the eye is illuminated by the ophthalmoscopic mirror. Cataract is said to be *primary* when it arises apparently independently of any other ocular inflammation, and *secondary* when it follows some local disease. The former is nearly always symmetrical, the latter may or may not be so. In advanced life a greyish reflex is always obtained from the pupil in consequence of the normal lenticular changes, and this is sometimes mistaken for cataract, but transmitted light shows no loss of transparency.

Varieties and diagnosis.—*Senile cataract* is the most common form, and seldom occurs before fifty years of age. It may begin in the nucleus or cortex. Nuclear cataract appears as a central amber-coloured haze. The cortical variety generally at first presents the appearance of striæ, often only visible after dilating the pupil. These striæ gradually increase in

number and breadth, the nucleus gets hazy, and ultimately the whole lens becomes opaque (*mature cataract*). Occasionally we simply find numerous minute dots of opacity in the cortex, best seen by direct ophthalmoscopic examination with a strong convex lens behind the mirror ; such cataracts are exceedingly slow in progress. The time necessary for maturity varies in different individuals, but the average time taken by the usual senile cataract is from two to four years from the first observed impairment of vision. In a cataract just ripe for removal, the opacity is found on oblique illumination to be quite up to the anterior capsule, or on a level with the pupillary edge of the iris, and the lens has frequently a spermaceti-like lustre. It is always symmetrical, but one eye is generally in advance of the other. If not extracted it usually undergoes further degenerative changes, often becoming hard and calcareous ; sometimes the cortex liquefies, while the nucleus remains hard (*Morgagnian cataract*).

Lamellar cataract is either congenital or forms in early infantile life, and is generally associated with the occurrence of convulsions. The permanent teeth, especially the incisors, canines, and first molars, often show deficiency of enamel in patients with this affection. The opacity is seldom very dense, and affects an intermediate zone of the lens, the nucleus and periphery remaining clear. On dilating the pupil artificially we find that the margin of the lens is clear, and that there is also a layer of transparent lens substance anterior to the opaque area. The opacity itself is round, with occasionally sharp opaque spicules projecting radially from its margin. Its size varies in different cases, but is nearly always similar in the two eyes of the same patient, and shows little or no tendency to increase.

Congenital cataract may present different forms of opacity, but it usually involves the whole lens, and is

almost always symmetrical in the two eyes. There is frequently nystagmus.

Pyramidal cataract is always the result of ocular inflammation in early life, and usually of perforating corneal ulcer from ophthalmia neonatorum. It appears as a small, sharply defined, dense white opacity at the anterior pole of the lens, sometimes projecting forwards towards the cornea in the form of a small pyramid with its base slightly embedded in the lens substance. Once developed it does not increase in size.

Posterior polar cataract, as the name implies, is an opacity at the middle of the posterior surface of the lens. It is not sharply limited, but usually thins out irregularly from a denser centre; it is not stationary. By focal illumination it is generally of a yellowish colour. It is often due to disease of the vitreous dependent on choroidal inflammation.

Diabetic cataract is usually cortical at first, and when mature presents much the appearance of an ordinary senile cataract, but with the spermaceti lustre very distinct. The age of the patient often leads us to suspect glycosuria in such cases. When occurring early in life the diabetic form is soft, instead of being hard like the senile cataract, and reaches maturity very quickly, often in a few months from its first detection.

Subjective symptoms.—There is visual failure where the opacity is at or near the axis of the lens. As the cataract spreads and becomes denser, the sight fails more and more, until the patient, with his back to the light, can barely count fingers at a few inches, or only distinguish the hand moving before his eye. Many subjects of cataract, especially where the nucleus is principally affected, see best in a dull light, as the large pupil then allows the rays to pass through the clearer peripheral parts of the lens.

Causes.—The manner of production of an ordinary

primary cataract is not understood. It is often found associated with general senile changes, with arterial disease, gout, and especially with glycosuria. When cataract results from some local disease, such as choroiditis, old iritis, glaucoma, detached retina, intra-ocular tumour, etc., it is called "secondary," and is then frequently uniocular. Traumatic cataract will be considered later.

Treatment.—We can often improve vision considerably in the early stages of senile cataract by keeping the pupil under the influence of a weak mydriatic.* In some slight cases of lamellar cataract no operation is necessary, the patient seeing sufficiently well for all practical purposes. Before attempting any operation we should examine the condition of the eye and of the patient carefully. Thus, if the eye be perfectly blind, it is needless to remove the cataract. Again, if the projection be bad, if there be traces of old iritis, if the cornea be nebulous, or if the patient be suffering from glycosuria or other form of malnutrition, the prognosis must be guarded accordingly, and special care taken in the operation and in the after-treatment. To test the projection, light is thrown into the eye by the ophthalmoscopic mirror from different points of the visual area; if the patient can always indicate truly the direction from which it comes, his projection is good. If there be lacrymal obstruction or conjunctivitis, operation must be deferred till the condition is cured. The *operative treatment* indicated varies according to the consistence of the cataract; or, which is practically the same thing, the age of the patient. Under thirty-five years of age the cataract is always soft, and the best means of removing it are: (1) *discission*, the lens being needled and allowed gradually to become absorbed in the aqueous; and (2) *removal by*

* Atrop. sulphat. gr. ¼; zinci sulph. gr. ⅛; aq. destill. ʒj. One drop every second day.

suction or curette, generally after a previous breaking up of the lens substance by needling. After any such operation, ice compress must be applied for twenty-four hours, and the eye kept under atropine until all redness has disappeared. In the case of *hard* cataract, (after thirty-five years of age) the lens should be extracted entire. The modified Graefe incision with a long narrow knife is that usually now adopted, the puncture and counter-puncture being made at the apparent sclero-corneal junction, about the level of the upper border of the undilated pupil, and the centre of the incision coming just within the apparent upper corneal margin. An iridectomy is then performed (if not done as a preliminary step at least six weeks previously), the anterior capsule opened freely, and the opaque lens extracted through the corneal wound by pressing with a curette against the lower part of the cornea. All cortical matter must be carefully removed. After the operation both eyes are covered with dry cotton wool and an appropriate bandage, the patient being kept in a darkened room, and the eyes bathed gently every morning and evening for the first week. On the earliest symptoms of iritis leeches must be applied to the temple, and atropine drops put into the eye. Should the edges of the wound become infiltrated with pus, hot fomentations are advisable, and eserine drops six times daily, or powdered iodoform dusted into the eye twice daily. Should panophthalmitis occur, it is better to excise the eye early, as thus much needless pain is avoided. A bandage should be used over the eye even in favourable cases for at least a fortnight, and both eyes carefully shaded from light. After a couple of months the eye may be tested for glasses, +10D being about the average lens required for distance, and +14D for close work. Should the distant vision be unsatisfactory, the pupil must be examined by focal illumination, as frequently an

opaque membrane is found covering it. If present this membrane must be torn through with one or two needles, so as to leave a clear aperture corresponding to the centre of the cornea. After this secondary operation ice and atropine must be used, and the eyes kept shaded until all irritation and injection subside. For all cataract operations cocaine is most serviceable, but it must be remembered in performing iridectomy under its influence that it does not fully deaden the sensibility of the iris.*

Injuries.—(1) *Traumatic cataract* is the result of any injury by which the lens capsule is opened. It may follow a penetrating wound of the globe, or may simply be due to a direct blow rupturing the lens capsule. In recent cases ice compress and atropine drops must be used. A small piece of metal is sometimes embedded in the lens, and may be removed by the electro-magnet. Should the lens swell so as to produce increased tension, it must be removed by curette or suction. In young patients the cataract sometimes undergoes slow spontaneous absorption, as after the operation of discision. If severe iritis supervene, in cases due to punctured wound, early excision is advisable, as the eye will never be a serviceable one, and is very likely to set up sympathetic inflammation. (2) *Dislocation of the lens* is occasionally the result of a direct blow on the eye-ball. It is generally still enclosed in its capsule, and is commonly displaced downwards, its upper edge being still visible through the dilated pupil. It ultimately often becomes cataractous, and sometimes causes glaucoma. Occasionally the dislocated lens lies in the anterior chamber. From either situation it may be removed

* Solutions of all alkaloids used after any perforating wound of the eye-ball should be freshly prepared, as the fungoid growths which soon form in them seem sometimes to have a most prejudicial effect.

by the spoon through a large peripheral corneal incision, but the operation is one of great delicacy and liable to be accompanied by much loss of vitreous.

Congenital abnormalities.—*Congenital cataract* has been already alluded to. Occasionally we find partial *congenital dislocation of the lens,* usually in both eyes. Appropriate glasses are often serviceable in such cases.

Diseases of the Optic Nerve.

Developmentally and structurally the optic nerve is unlike ordinary cerebro-spinal nerves, and is to be regarded as a direct prolongation of the brain. It is peculiarly liable to suffer in affections of the central nervous system, in certain general diseases, and in some forms of chronic poisoning.

Inflammation of the optic nerve.—*Pathology.* The intra-ocular end of the nerve ("*papilla*") is the part most commonly inflamed, and to this condition the term "*papillitis*" is conveniently applied. When the inflammation first attacks the nerve trunk behind the eye-ball, we speak of it as a "*post-ocular neuritis.*" The expression, "*optic neuritis,*" should be retained as a general term for inflammation of any part of the nerve. Optic neuritis may be acute or chronic, may occur at any point in the course of the nerve, may affect the whole thickness or only a part of it, and may or may not lead to permanent atrophy. Where the periphery of the nerve is mainly involved, we call the condition "*perineuritis;*" where the inflammation attacks the central part of the nerve we speak of it as "*axial neuritis.*" Usually both nerves are affected, though not necessarily to the same degree nor consentaneously; unilateral optic neuritis is generally dependent on a local cause, such as orbital cellulitis. In the early stage of a papillitis, the connective tissue is unaffected; and if the inflammation

proceed no further, we may finally get a healthy disc and retention of normal vision. Usually, however, we ultimately get interstitial changes.

Symptoms.—There is usually no ocular pain, and there may not even be loss of sight for some time. In exceptional cases, indeed, papillitis may run its course and disappear again without there being any impairment of vision, but usually sight fails gradually. The manner of the failure varies according to the kind of the neuritis. In ordinary papillitis we have a progressive loss of central vision along with a peripheral diminution of the visual field. In some cases of post-ocular neuritis, in the axial form for example, we have the central vision alone first impaired, the peripheral field remaining perfect; in such cases the loss of colour vision is characteristic, the power of distinguishing red and green, in a small central area, being often lost at the very commencement of the affection.

Ophthalmoscopic appearances.—We must exercise much caution in diagnosing positively the slighter departures from the normal vascularity of the papilla, and we must invariably examine both eyes. In simple passive congestion of the papilla, it is redder than normal, and the veins are somewhat dilated, but there is no swelling, and though its margin is wanting in definition, it is not actually obscured. Between such a condition and a fully developed papillitis or "choked disc," there are many gradations, which may simply be stages in the development of a high degree of papillitis, or any one of them may be the final condition where the inflammation is of less severity. In advanced papillitis the changes are unmistakable; we find swelling of the papilla, with obscuration of its margin, loss of translucency, increased vascularity, and obliteration of the physiological cupping. Numerous straight vessels radiate from it on every

side, coursing over its obscured edge, and small hæmorrhages often occur on or near it. The veins are distended, dark and tortuous, and the arteries usually somewhat narrowed; both sets of vessels, but especially the arteries, are often hidden on or near the disc. Smooth, opaque, whitish spots occur on the papilla or on the surface of the adjacent retina, concealing completely what they cover, and there are often large areas of cloudiness in the retina. As the papillitis subsides, the redness and swelling diminish, and the disc margin again comes into view. The disc is first opaque and "woolly" looking, but gradually becomes smoother, and is ultimately (stage of atrophy) of a white colour, with concealment of the lamina cribrosa; around it there is often a pale zone from changes in the retinal pigment; the vessels are all much narrowed, and are often bordered by opaque white lines.

Causes.—(*a*) A large majority of cases of papillitis are due to *intracranial disease; e.g.* tumours, meningitis, cerebral abscess, internal hydrocephalus, aneurism of internal carotid. Injuries to the head may cause optic neuritis either through meningitis, effusion of blood (within the skull or within the nerve sheath), hernia cerebri, or possibly through a laceration of the brain.

(*b*) We are liable to get optic neuritis (usually one-sided) in many *orbital affections; e.g.* tumours, cellulitis, periostitis, etc. In the case of orbital tumour there is generally protrusion of the eye-ball.

(*c*) Papillitis has been observed in association with acute *myelitis*, and in cases of injury to, and caries of, the cervical spine.

(*d*) In *general diseases*, *e.g.* progressive pernicious anæmia and Bright's disease, but in cases of the latter we usually have a characteristic retinitis in addition. Acquired syphilis may cause optic neuritis either through meningitis or from a gummatous growth,

which latter may be within the skull, or at the optic foramen, or on the nerve trunk, the neuritis being generally one-sided when in either of the two last situations. In diabetes mellitus we get an axial neuritis, and probably the same limited inflammation is caused by chronic poisoning by lead, alcohol, tobacco, and bisulphide of carbon.

(*e*) Sometimes optic neuritis is simply an extension of inflammation from a neighbouring ocular tissue.

The **prognosis** must always be guarded as to the final condition of vision, and depends more on the cause than on the intensity of the papillitis observed. It is relatively more favourable where the cause is removable or amenable to remedies. We may have a papillitis with good vision, leading ultimately to complete atrophy and blindness, while again we may have a papillitis with the barest perception of light, followed by almost perfect recovery.

Treatment.—Where not contra-indicated, mercury and iodide of potassium should be employed as a matter of routine, the latter being given in full doses. Perfect rest must be insisted upon, and the cause is to be treated by appropriate remedies when possible, or to be removed altogether in the case of exposure to poisons. Locally, dry or wet cupping, or blisters to the temple, may be tried, and ice to the forehead has been recommended in an early stage.

Atrophy of the optic nerve.—*Pathology.* In all cases of atrophy the nerve is ultimately affected in its entire length. In all true cases the nervous elements are involved, and there is a corresponding loss of function. In the *post-neuritic* atrophic process the nerve fibres finally either break down and are removed, or undergo grey degeneration; in the former case the diameter of the nerve is much reduced from contraction of the hypertrophied fibrous tissue. In *simple* atrophy there is seldom much increase of

connective tissue, but the nerve fibres lose their medullary sheath by a process of granular fatty degeneration, while the axis cylinders are usually retained, but converted into fine indistinct fibrils; there is consequently little change in the size of the nerve. This "grey degeneration," as it is termed, may be *diffuse*, affecting the whole nerve uniformly, or *insular* and varying much in extent in different sections. In most cases of atrophy both nerves are affected, though one may be considerably in advance of the other.

Causes.—All cases may be divided broadly into *inflammatory* and non-inflammatory or *simple*. (1) Those due to inflammation are traceable either to a papillitis, a post-ocular neuritis, or an inflammation of the choroid or retina. (2) Simple atrophy may be primary or secondary. In the *primary* form we get visible atrophic changes occurring consentaneously with gradual failure of vision, often in association with disease of the central nervous system (locomotor ataxy, etc.). The more immediate cause of this form seems to be severe bodily fatigue, anxiety, exhausting brain work, sexual excess, etc. In the *secondary* form of atrophy the loss of vision precedes the visible atrophic changes. This occurs in all cases where interrupted conductivity in one part of the nerve leads to subsequent atrophy in the remainder, as where the nerve has been cut across, or torn through, or pressed upon (by tumours, foreign bodies, etc.), or has had its blood supply interrupted (as from embolism). Syphilis may induce either a post-inflammatory atrophy or a secondary one (as from pressure of a gumma), and a specific history is also common in cases of simple grey degeneration.

Symptoms.—The failure of vision in post-neuritic cases has been already described. (*See* page 590.) In atrophy from choroiditis and retinitis the failure is usually gradual, central vision often remaining fairly

acute while the rest of the field has become amblyopic. In the secondary form of simple atrophy vision often fails suddenly. In primary atrophy the loss of vision is slow and continuous, there being both central failure and contraction of field. Affection of the colour sense is almost constant, green being generally first confused, while later perception fails for red, blue, and lastly yellow. The pupils are generally wide in post-papillitic atrophy, small in spinal cases, and often of medium size in other forms.

Ophthalmoscopic appearances.—The colour of the atrophied disc is white, grey, or of a blueish or grecnish tint. The disc is often excavated quite up to the margin all round, but never deeply, and the slope is gradual. The lamina cribrosa may or may not be visible. The edge of the disc is usually well defined. The central blood-vessels are in some cases much diminished in size, in others only slightly if at all. In the post-papillitic form the disc margin is often irregular-looking from loss of pigment due to choroido-retinal changes; the central vessels are reduced in size, and frequently bordered by opaque white lines; the excavation is absent or slight, and the lamina cribrosa is invisible. In atrophy from choroido-retinal disease the disc has usually a peculiar opaque, yellowish-red, "waxy" look, and the retinal vessels are greatly diminished in size, and sometimes in number. In the partial atrophy from axial neuritis the pallor is confined to the temporal half of the disc.

The **prognosis** is always unfavourable, but is relatively less so where the cause is removable or may pass away spontaneously. In some of the post-papillitic cases considerable improvement takes place if the sclerosing process do not lead to much pressure on such nerve fibres as have escaped destruction by the inflammation. In marked contraction of the visual

field, and in cases of long-standing amblyopia, little or no improvement is to be expected. In cases of primary atrophy, almost complete blindness generally occurs in from one to three years.

Treatment.—Where the atrophy is dependent on some general condition or toxic influence, the treatment must be regulated accordingly. Nervine tonics, such as strychnia, are said to be occasionally useful. Where the atrophic process has not gone too far, the continuous current is sometimes beneficial. One pole should be applied over the closed eyelids and the other over the supra-orbital nerve, the current being broken frequently and the poles transposed. The smallest number of cells which will give the physiological light-flash on making and breaking the circuit should be employed; the whole sitting should last about five minutes, and be repeated daily for at least a month. If no improvement take place during this time, either in central acuity or in visual field, galvanism may be abandoned as useless. If any marked benefit result, the current should continue to be employed at longer and longer intervals, as the condition may indicate. The patient is quite capable of carrying out the treatment for himself after having once been properly instructed.

Injuries.—The optic nerve may be injured by a blow, stab, gun-shot wound or fracture of the sphenoid bone. A severe blow on the side of the eye-ball may cause rupture of the nerve at its entrance into the globe. A stab or thrust into the orbit may cut or tear the nerve, or cause an extravasation of blood within its sheath, or may sever the central vessels outside its trunk. A foreign body penetrating deeply may produce fracture of the orbital walls or of the clinoid process of the sphenoid bone, thus leading to injury of the nerve. Gun-shot wounds may implicate either the orbital or intracranial part of the nerve,

and pellets or metallic fragments may penetrate the globe and become embedded in the papilla. Fracture of the base of the skull sometimes causes injury to the nerve at the optic foramen, or behind it if the clinoid process be displaced. Any severe injury to the nerve usually occasions sudden complete blindness of the corresponding eye. If the solution of continuity be incomplete, or if the nerve be simply bruised, we may get partial or complete restoration of vision, but secondary changes often occur leading to ultimate atrophy.

The *ophthalmoscopic appearances* differ according to the nature of the injury. If the central artery be divided the changes are like those met with in embolism of this vessel. In other cases the disc remains normal in aspect until the atrophic process reaches it, when it gradually assumes the appearance of an ordinary secondary atrophy with normal vessels. The *treatment* of the recent injury must be based on general surgical principles. Later on, if the continuity of the nerve has been preserved, galvanism may be of some service.

Tumours.—The intra-ocular end of the nerve may be affected secondarily in sarcoma of the choroid or in retinal glioma. The most common form of tumour proper to the nerve trunk is the myxo-sarcoma. It leads to proptosis, papillitis or simple atrophy, and early blindness; the ocular movements are usually good, and there is little or no pain. The intracranial part of the nerves and the chiasma are especially liable to gummata, and the chiasma may also be the seat of a deposit of cheesy tubercle.

DISEASES OF THE RETINA.

With the exception of its blood-vessels and its pigment epithelium, the retina is almost perfectly transparent, and consequently practically invisible

ophthalmoscopically. Its diseased conditions may therefore be recognised by a loss of its transparency, or by changes in its circulation or in its pigment layer. Its transparency may be lost over a small or large area from hæmorrhages, deposits of pigment, œdema, exudations, or fatty changes.

Hæmorrhages may occur at any part of the fundus, and may be single or multiple, small or large. When recent they present a bright red appearance, but become darker with time, and undergo slow absorption. If large, they may either burst into the vitreous or cause detachment of the retina. When in the nerve fibre layer they present a striated or "flame-shaped" appearance, and when in the deeper layers they are round or irregular. They interfere with vision according to their size and position, those at the yellow spot causing necessarily much impairment.

Causes.—They may accompany inflammation of the retina or optic nerve, but are more frequently dependent on general conditions, or on retinal disease consequent on general conditions. They are generally due to rupture of vessels, as from increased intravascular pressure (*e.g.* in cases of contusion of the eye-ball, optic neuritis with much constriction of veins, violent effort, or high arterial tension), or from sudden diminution of the vitreous support (following wound of the globe), or from weakness of a degenerated vascular wall. Diapedesis may possibly occasion visible hæmorrhages in cases where there is an altered condition of the blood, *e.g.* in diabetes, severe anæmia, leucocythæmia, purpura, pyæmia, etc. They are also commonly found in association with the hæmorrhagic diathesis.

The *treatment* must be mainly determined by the patient's general condition, but local application of ice may be employed in recent cases.

RETINITIS

is usually the result of some general disease, and the classification of its forms usually adopted is a clinical one.

Symptoms.—The loss of vision, both temporary and permanent, varies much in different cases. *Ophthalmoscopically* we find loss of retinal transparency, venous dilatation, and a tendency to the occurrence of hæmorrhages and white patches.

The **treatment** depends mainly upon the patient's general condition. Complete rest must be ordered, and all strong light cut off by wearing dark neutral tint glasses. Counter-irritants and leeches to the temple are sometimes advisable.

Varieties.—1. *Hæmorrhagic retinitis* occurs in association with disease or disorders of the circulatory system, and usually affects one eye only. The hæmorrhages are small and numerous.

2. *Albuminuric retinitis* is most commonly associated with chronic kidney disease, especially the contracting form, but is also frequently found in the albuminuria of pregnancy. There are numerous light-coloured, soft-edged patches in the retina; minute, opaque, very white dots or striæ at the yellow spot, arranged in the form of an asterisk, with its centre at the fovea; and generally papillitis and hæmorrhages. These changes may subside if the renal affection improves, those at the macula, however, lasting for a long time. In the cases associated with pregnancy we may get perfect vision restored with a normal fundus.

3. *Syphilitic retinitis* usually comes late in the secondary stage, about the end of the first year or later. The ophthalmoscopic changes are generally slight; the larger veins distended and dark, and the disc outline blurred. Very commonly there are numerous dust-like opacities in the vitreous. The visual failure is considerable, and the attack lasts for months,

but the result is generally favourable. The *treatment* must be energetically anti-syphilitic, mercury being the remedy chiefly to be relied on. In leucocythæmia, and more rarely in diabetes, retinitis may also occur.

Retinitis pigmentosa is a term used for a disease where a certain group of symptoms and definite course are usually found in association with pigmentary changes in the retina. The disease is symmetrical and chronic, usually beginning in early life and terminating in blindness soon after middle age. Night blindness is the earliest and most characteristic symptom. There is soon loss of visual field, the central area remaining longest. *Ophth.:* We find a yellowish-red, "waxy" atrophy of the disc, narrowed retinal vessels, and much pigment in the retina, black masses, shaped somewhat like bone-corpuscles, lying superficial to the retinal vessels. Galvanism is the only form of *treatment* of any avail; it sometimes causes improvement both in field and in central acuity.*

Thrombosis may occur in the central artery or vein, but neither form merits separate description here. We may get **embolism** in the central artery or in one of its branches. It is rarely bilateral, and is more common on the left side; the usual cause is cardiac disease. In a case of complete plugging, the leading symptom is sudden blindness of one eye. *Ophth.:* The disc is pale, with slightly blurred edges. There is a diffuse haze of retina, best marked in the region of the macula; corresponding to the fovea centralis is a bright red spot. The arteries near the disc are often reduced to mere white threads. The only *treatment* that has proved sometimes beneficial is massage of the eye-ball, probably best performed by alternate prolonged, moderately firm, pressure over the globe and sudden removal of this pressure.

In **retinal detachment** the retina proper is

* For its manner of employment *see* page 595.

separated from its pigment epithelium, and a serous fluid usually occupies the interval. The fluid may be effused primarily as a hæmorrhage, or as a serous exudation in connection with inflammation or tumour of the choroid. The common reason of detachment, however, is some alteration in the vitreous, either a mere diminution of its support to the retina, or contraction of connective tissue formations within it dragging the retina away from its normal position. Retinal detachment often occurs in cases of progressive myopia. On illuminating the eye, with the mirror held at twelve to eighteen inches' distance from it, we find that some part of the fundus gives a blueish-grey or whitish reflex instead of the normal red seen elsewhere. This discoloured detached portion is usually folded and tremulous, and on its surface the retinal vessels run as distinct, slender, dark, tortuous lines. In a recent shallow detachment we find no such difference in colour, but its vessels have the characters just mentioned. We should always note the extent, mobility, depth, and degree of folding of the detachment; we are thus in a position to decide as to the probable nature of the displacing agent.

Symptoms.—There is frequently a history of sudden impairment of vision. Generally the detachment gradually extends until there is finally complete, or almost complete, blindness.

Treatment.—Rest in the recumbent position in a dimly lighted room, with a pressure bandage over the eye, is advisable in recent cases. Puncture of the sclerotic at the site of the displacement, so as to permit the subretinal fluid to escape, is recommended, and this certainly sometimes improves vision considerably for a time.

Glioma of the retina is essentially a disease of early life. It commences insidiously, without inflammation, grows rapidly, and if left to itself soon

leads to the death of the child, spreading both centrally and peripherally.

Diagnosis.—The attention of the parents is generally first aroused by seeing a whitish reflex from behind the pupil. By this time there are often signs of secondary glaucoma, and the eye is sometimes tender. By focal illumination we see a yellowish-white, rounded or lobulated, solid-looking mass in the vitreous, with blood-vessels and often small hæmorrhages on its surface. The vessels are distinguished from those found on a detached retina by their irregular distribution, different mode of branching, greater breadth, and somewhat brighter colour.

The *treatment* is early removal of the affected globe, with as much nerve as we can conveniently get. If the other orbital contents are affected, while the nerve at the point of section appears healthy, it is advisable to thoroughly clean out the orbit and then destroy the surface with chloride of zinc paste. When the tumour has attained a large size it is often prudent to leave it alone, simply giving opiates, if necessary, to relieve pain and induce sleep.

Congenital abnormality.—Opaque nerve fibres usually occur as a brilliantly white patch, narrower at the end next the papilla, with which it is nearly always continuous. Its broader peripheral end has a teased out, brush-like appearance from separation of the fibres. The affected fibres are generally above or below the disc, concealing the large blood-vessels more or less. We get a blind spot corresponding to the extent of the opaque area.

Diseases of the Choroid.

Choroiditis.—From the absence of subjective symptoms of inflammation, its occurrence is usually diagnosed from vitreous changes, or from subsequent choroidal atrophy seen ophthalmoscopically as white,

yellow, or black spots or patches. These latter vary in size from mere fine points to areas much larger than the disc, and their form is round or irregular. They may occur only at the macula, at the equator, or over the entire fundus. One of the best marked clinical varieties is *choroiditis disseminata*, in which the atrophic spots are generally round, white, and bordered by a ring of black pigment; they occur scattered over the fundus, but principally towards the periphery. This variety is usually symmetrical, and in association with syphilis.

Causes.—Syphilis, myopia, senile degeneration. When seen in an early stage or while the sight is still failing, the *treatment* should consist in rest, and antisyphilitic remedies when indicated.

Purulent choroiditis leads to secondary infiltration of the vitreous, recognised by a yellow reflex. It is often an early stage of panophthalmitis, and always leads to wasting of the globe.

Causes.—Injury, septic emboli (as in puerperal fever and pyæmia). A less acute form is met with in epidemic cerebro-spinal meningitis, tuberculosis, etc., leading to a whitish reflex from the vitreous and partial phthisis bulbi (pseudo-glioma).

Treatment.—In traumatic panophthalmitis, early excision.

Posterior staphyloma.—A certain amount of it is often merely a stationary congenital peculiarity, usually found with myopia, and exceptionally with emmetropia and hypermetropia. It generally occurs as a whitish crescent at the outer edge of the disc, with sharp, even boundaries and a dark border. Another form is progressive, and associated with high degrees of myopia; here the boundaries are less marked and frequently indented, the pigment border is interrupted, and there are often other distinct patches of choroidal disease in its vicinity.

Tubercle of the choroid is generally found in the neighbourhood of the macula and papilla, and usually in both eyes. *Ophth.:* Yellowish-white, round, somewhat raised spots, varying much in size.

Cause.—Usually miliary tuberculosis in young subjects.

Rupture of the choroid, from a direct blow on the eye-ball, generally occurs near the posterior pole of the globe in the form of a crescent, with its concavity towards the disc. *Ophth.:* The fissure is white or yellowish white; when fresh, hæmorrhages are often found at or near it, but later we get a black pigmented border.

Coloboma is a congenital defect at the lower part of the choroid, the result of imperfect closure of the fœtal cleft. It is generally of large size, often extending from the disc to the periphery. *Ophth.:* We find an uneven surface of exposed sclerotic with tortuous vessels on its surface, and often surrounded by black pigment. Coloboma of the iris frequently accompanies it.

Tumours.—*Melanotic sarcoma* is much the most common form; it generally occurs at or past middle life, and especially in eyes damaged by injury or disease. Usually the patient is first seen in a comparatively late stage, with the retina largely detached, the eye glaucomatous, and the lens often cataractous. A positive diagnosis is then difficult, and we must rely chiefly upon the history. Whenever we have reason to suspect its presence, we should excise at once. If the nerve at the point of section be affected, and still more if the tumour have perforated the outer coats of the eye-ball, all the contents of the orbit must be removed, and chloride of zinc paste applied.

DISEASES OF THE VITREOUS.

Opacities in the vitreous are generally due to inflammatory affections of this structure, occurring secondarily to disease of the ciliary body, choroid, retina, or optic nerve. They are common in cases of high myopia. They may also be the result of hæmorrhages (from rupture of retinal or choroidal vessels), or of degeneration, especially senile. Occasionally we get cholesterin crystals in a fluid vitreous, appearing as a sparkling golden shower on movements of the eye (*synchysis scintillans*). All vitreous opacities are best examined with a plane or slightly concave mirror held at twelve to eighteen inches from the patient's eye. On his turning his eye smartly upwards, downwards, or laterally we detect the opacities against the red background as dark webs or dots which are still in motion after the eye has come to rest. By their rapidity and extent of movement we can judge of the consistence of the vitreous. Sometimes the opacities are very minute, like small dust particles diffused throughout the vitreous, *e.g.* in specific choroiditis; these are well seen by using a strong convex lens (+18D) behind our mirror held close to the patient's eye so as to focus them accurately.

Symptoms.—He generally complains of seeing black specks floating about, and sometimes, especially where the opacities are large and central or diffuse, vision is much reduced.

Treatment.—Heurteloup's leech to the temple, along with the remedies appropriate to the exciting cause. The dust-like opacities associated with specific disease usually disappear under a mild mercurial course.

Suppurative hyalitis occurs from injury or from a purulent choroiditis. We get a yellowish reflex from the purulent deposit, the tension is reduced, and

there is generally iritis. The prognosis is unfavourable, the eye being usually lost.

Foreign bodies in the vitreous.—If the eye have suffered irreparable damage, and vision be much affected, early excision is best. Where the lens and ciliary region have escaped, and there is no evidence of iritis or choroiditis, we may try to remove the foreign body. If it be of steel or iron, the electromagnet is exceedingly useful for this purpose. If it be of other metal, or of glass, etc., it will be found extremely difficult to effect its removal, unless placed well forward in the equatorial region. If evident inflammation of any part of the uveal tract occur the eye should be excised.

Cysticercus is sometimes found in the vitreous, but it is very rare in this country. **Persistent hyaloid artery** occasionally is met with, appearing as an opaque cord running forward from a branch of the central artery on the disc.

Glaucoma.

We have already mentioned the occurrence of *secondary glaucoma* in several ocular affections ; we have now to consider the primary form of the disease.

Symptoms and mechanism.—Primary glaucoma consists mainly in an increased tension of the eye-ball due to excess of fluid within the vitreous chamber, and is most apt to occur when the sclerotic is unyielding and thick, as in old hypermetropic eyes.*

* In examining tension the patient stands facing us with head erect, and looks down towards his feet. We now place one finger of each hand on the upper lid of the eye to be examined, as near the upper orbital margin as possible, and press the globe lightly downwards. Each finger is used alternately simply to steady the globe, and to estimate the resistance offered to light pressure when steadied by the other finger. The tension of the two eyes should always be compared. The student should thoroughly acquaint himself with the average tension of the normal eye, so that he may have a mental standard with which to compare alterations in disease.

This excess of fluid is partly due to increased secretion and intra-ocular vascular congestion, partly to diminished escape. Continued high tension in the vitreous chamber will mechanically affect every part of its enclosing walls. The soft ciliary body soon yields to it, and we get rapid failure of accommodation (shown by increase of presbyopia), often a valuable early symptom of the disease. The ciliary nerves are also affected by the pressure, and this result assists in diminishing the accommodation, besides leading to dilatation and inactivity of the pupil, and to corneal anæsthesia. A sudden access of tension interferes with the circulation in the choroidal vessels, and we consequently get congestion of the perforating and other branches of the anterior ciliary veins outside the globe. The lens is pushed forward by the pressure behind, and the anterior chamber rendered shallow in consequence. The peripheral part of the iris is also pressed forward, and often becomes adherent to the inner surface of the cornea. The optic nerve and lamina cribrosa, being of less resisting power than the sclerotic, ultimately yield, leading to cupping and atrophy of the disc. The intra-ocular tension being as great as, or even greater than, that in the central retinal artery except during systole, we get arterial pulsation evoked by gentle finger pressure on the globe, or occurring spontaneously. From the impeded blood supply, and the pressure on nerve fibres, there is loss of function, the nasal field being first affected. Other symptoms of glaucoma are steaminess of the cornea and pain, and the patient often sees coloured halos round a flame. The pain varies greatly in different cases, being sometimes absent, and sometimes very severe, referred to the eye, occiput, and back particularly, and often then associated with sickness and vomiting.

Course.—Glaucoma is distinctly a progressive

disease, leading to blindness, but the rate of its progress and the severity of its symptoms are liable to much variation in different cases, and often in the same case at different times. In consequence of this variability, different forms of the affection are described as acute, subacute, and chronic. In the *acute* form the symptoms appear suddenly, and are very severe, the congestion and pain being especially marked, and the tension very high. Vision fails rapidly, and is generally abolished in a week or so if the acute symptoms continue, and sometimes even in a few hours (*G. fulminans*). In *chronic* or *simple* glaucoma there is no congestion and seldom pain; the tension is never very high, and all the other symptoms are proportionately modified and the progress gradual, lasting for months or years before causing total blindness. The *subacute* form is intermediate in severity, and is the most common in occurrence, frequently, indeed, appearing intermittently in an otherwise chronic case. There are considerable congestion and pain, and the vision fails rapidly; such an attack, if continuous, leads to complete blindness in a few weeks. Glaucoma usually attacks both eyes, though not necessarily in the same form, and often with a long interval. The second eye is especially liable to an attack immediately after an operation (*e.g.* iridectomy or excision) on the one first affected.

General causes.—It seldom occurs before forty-five years of age, and is most common in women and in hypermetropic eyes. Grief, anxiety, overwork, or the local use of atropine, are apt to bring on an acute attack in those otherwise predisposed. Its subjects are often gouty. The different theories as to the pathological origin of glaucoma cannot be discussed here. The fundamental aim of all such theories is either to explain a hypersecretion of the intra-ocular fluids, or to account for their abnormal retention within the globe.

Treatment.—*Iridectomy* gives much the most satisfactory results, and often affords permanent relief. The incision should be made well behind the apparent corneal margin, and the excised piece of iris removed well up to its ciliary attachment. This operation is particularly indicated in all acute and subacute cases, and should be performed at the earliest possible opportunity. When a painful glaucomatous eye is permanently blind, iridectomy may be done for relief of pain, but enucleation is usually preferable in such cases. In true chronic glaucoma treatment is often of no avail, but even here iridectomy is always worth trying, as it is more likely than anything else to give relief. Some surgeons prefer *sclerotomy* in this form of the disease, the operation consisting practically in a large incision through the anterior part of the sclerotic, without iridectomy. *Eserine* is often serviceable by keeping the tension temporarily diminished in the more acute cases, when for some reason iridectomy must be deferred. It may also be used in chronic forms as a preliminary to, or instead of, operation.* Eserine should always be employed as a prophylactic agent for the one eye when the other requires operation for increased tension; in such a case it is sufficient to use it just before, and for two or three days subsequent to the operation. In all cases of glaucoma rest must be insisted upon, errors in diet avoided, and causes of mental excitement, as far as possible, removed. Atropine and similar mydriatics must never be used where a predisposition to glaucoma exists, still less when the disease is actually present.

* In glaucoma I have found a solution containing eserine and cocaine serviceable, the latter (by its stimulant action on the sympathetic nerves) presumably preventing the internal vascular congestion usually caused by eserine. Such dilatation of pupil as cocaine would naturally cause, is readily overcome by very weak eserine. ℞ Cocain. hydrochlor. gr. v; eser. sulphat. gr. j; aq. destill. ʒj. One drop four to six times daily.

Errors of Refraction and Accommodation.

The eye sees by virtue of the rays of light which have passed through its pupil and reached its retina. For the formation of defined images, it is necessary that the rays coming from an object be accurately focussed on the outer segments of the rod and cone layer; the normal or *emmetropic* eye, with relaxed accommodation, is such that parallel rays are so focussed. In *myopia* the retina is placed too far back, so that parallel rays come to a focus in front of it, and the resulting retinal image is consequently ill-defined. In *hypermetropia*, on the contrary, the antero-posterior measurement of the eye is too short, so that the rays have not yet come to their focus when they reach the sentient retina, and a blurred image is again the result.

The rays coming from every point of an object are divergent, but when such object is situated at several feet distance from the eye, those passing through the pupil may, for all practical purposes, be considered parallel. It is usual to place our test object at six metres (or twenty feet) in testing the refraction of the eye at rest. To be accurately seen by the average eye, an object must be of such a size that it subtends an angle of five minutes, the apex of the angle being situated near the posterior pole of the lens, where the rays coming from all eccentric points of the object cross the principal axis. The test types usually employed (Snellen's) are made on this principle, and we express the visual acuity (V) by a fraction, the numerator corresponding to the distance (in metres or feet) between the patient's eye and the test, the denominator being the distance at which the type ought to be distinguished by the normal eye. Thus, with normal vision, $V = \frac{6}{6}$ (or $\frac{20}{20}$), but if the smallest type read at six metres is that which ought to be distinguished at twelve or at sixty metres, $V = \frac{6}{12}$ or $\frac{6}{60}$; *i.e.* $= \frac{1}{2}$ or $\frac{1}{10}$th of normal vision. Each eye must always be tested separately.

We cannot here consider the subject of optics further than to remind the student that an ordinary convex or + lens renders divergent rays less divergent, parallel, or convergent, according to the amount of the divergence of the original rays and the strength of the lens. Rays already parallel it brings to a focus at a distance varying inversely with the curvature of the lens. By increasing the curvature of a lens, therefore, we augment its effect

on divergent rays, and render its focussing distance for parallel rays shorter. An ordinary concave or – lens increases the divergence of already divergent rays, and makes parallel rays diverge as if coming from a point in front of the lens; the interval between this point (or *virtual* focus) and the lens is the focal distance of the lens in question. A lens, whose focal distance is one metre, is called one dioptre (1 D), and is the unit of the metric system now generally adopted; a lens of two dioptres (2 D) is, therefore, twice the strength, or one-half the focal distance.

Emmetropia (*E*) and **presbyopia** (*Pr*).—Were it not for the power of accommodation, the normal eye would be incapable of seeing *near* objects distinctly, as the rays would be too divergent. By the action of the ciliary muscle, however, the curvature of the crystalline lens can be increased, so that rays of very considerable divergence can be brought to a focus on the retina. This temporary increase in curvature (or accommodation) is dependent on the elasticity of the lens substance, and diminishes with age. Whenever it has failed so much that objects must be placed at nine inches or more from the eye so as to be clearly seen, the condition of presbyopia is said to exist, and the increased curvature required must be artificially supplied by suitable convex glasses. Presbyopic glasses of 1D are necessary in the emmetropic eye at about 45 years of age, and they require to be increased by about 1D for each five years of life up to the age of 60, and afterwards by 0·5D for each subsequent five years.

Hypermetropia.—Although all objects must appear indistinct to the hypermetrope with relaxed accommodation, he is able to see distinctly by an effort of his ciliary muscle provided he be still young and the hypermetropia not very large in amount. Some such effort is necessary even for distant objects, but a greater is required for all near vision. In as far as convergence and accommodation are naturally consentaneous acts, such a hypermetrope is apt to develop a convergent concomitant squint, and a continuance of

the accommodative effort leads to fatigue, supra-orbital headache, and occasional blurring of images from failure to maintain the accommodation necessary. The glass suitable for such an eye is a convex one, of such a strength that parallel rays will, by its aid, be focussed on the retina without the use of accommodation. To overcome all action of the ciliary muscle in young people it is necessary to use atropine, but the full correction found under its use should not be ordered, a glass of 1 D less than this being most suitable. The hypermetrope should wear his glasses constantly.

Myopia.—For distinct vision the object must be comparatively near the eye, so that the rays coming from it and passing through the pupil have such a divergence that they will be focussed on the retina. Distant objects can only be rendered distinct by the aid of a concave lens, and the weakest that will give this result must be the one ordered. Should there be insufficiency of the internal recti, prisms with their bases inwards are often very serviceable for near work.

Astigmatism. — In *regular* astigmatism one meridian of the eye is of less refractive power than any other, and at right angles to this is the meridian of greatest refraction. If one meridian be emmetropic while the opposite is myopic or hypermetropic, we have respectively simple myopic or simple hypermetropic astigmatism. If both such meridians be unequally myopic the condition is called compound myopic astigmatism ; if both be unequally hypermetropic we have compound hypermetropic astigmatism. Again, if one meridian be hypermetropic, while that at right angles to it is myopic, the case is one of mixed astigmatism. The consequence of astigmatism is that no object is seen with perfect distinctness, but any straight line will be comparatively well defined *if at a suitable distance from the eye.* The correcting glass

required is a cylindrical one (+ or −), with a spherical in addition where the astigmatism is compound or mixed.

Affections of Ocular Muscles.

Convergent strabismus of a concomitant nature has already been mentioned when considering hypermetropia. It usually first appears in early childhood, and may only be periodic, or worse during strong accommodative efforts, but sometimes it is constant in presence and in degree. If both eyes see equally well, it is often alternating, affecting sometimes one, sometimes the other eye. In the constant form, diplopia is generally avoided by a mental suppression of the image from the squinting eye, which latter consequently becomes defective. Occasionally the squint disappears spontaneously after some years.

Treatment.—The glasses required for the hypermetropia are usually sufficient to prevent a concomitant squint if given sufficiently early. When the squint persists, however, after using glasses for some time, one internal rectus should be divided, and if this be insufficient the other eye may also be operated on some weeks later.

Divergent strabismus not infrequently occurs in myopia from insufficiency of the internal recti; here, again, diplopia seldom exists when the squint is constant. The *treatment* consists in giving the requisite glasses and dividing one or both external recti. Divergent strabismus also often affects an eye whose vision is defective, as from corneal opacities.

Ocular paralysis. — Paralysis of the nerves supplying the *extra-ocular* muscles leads to strabismus, and to diplopia, which latter is always more troublesome when the strabismus is slight, *i.e.* when the double images appear close together. The false image is always displaced in the direction in which the

affected muscle would act were it not paralysed. The strabismus is due to the unopposed action of the sound muscles. Such a paralysis is usually uni-ocular. The whole of the third nerve is seldom equally affected, one or more branches generally suffering more than the others. Very rarely we get all the extra-ocular muscles paralysed (*ophthalmoplegia externa*) in both eyes.

Paralysis of the intra-ocular muscles.—The iris (sphincter and dilator) and the ciliary muscle may be affected separately or together. In third nerve paralysis the sphincter iridis and ciliary muscle are usually both affected. Paralysis of all three intra-ocular muscles (*ophthalmoplegia interna*) is occasionally found.

Causes.—Syphilis is a frequent source of these affections, either by a periostitis (at the base of the skull or at the sphenoidal fissure) or by gummata somewhere in the course of the nerves or at cerebral centres. Other causes are meningitis, orbital or intra-cranial tumours and fracture of the skull. Some cases are said to be rheumatic in origin. Paralysis of the ciliary muscles (cycloplegia) is not uncommon after diphtheria. In an early stage of tabes dorsalis, temporary localised extra-ocular paralyses are sometimes observed, and in a later stage of this affection we get a form of iridoplegia in which the pupils do not react to light, but still contract on convergence of the eyes.

Treatment.—Where syphilis is a possible cause we should give a course of mercury and iodide of potassium. Galvanism may also be employed. Instillation of a weak solution of eserine ($\frac{1}{2}$ or 1 gr. to the ounce) is useful in post-diphtheritic cycloplegia. In some incurable cases the diplopia may be prevented by the use of prismatic glasses, and the pupil may be restored to its normal size and the ciliary muscle stimulated by a solution of eserine of an appropriate strength according to the effect desired.

Nystagmus, or involuntary oscillation of the eye-ball, may be vertical, horizontal, or rotatory. It is generally due to congenital or early infantile defect of vision, and usually affects both eyes. It is also occasionally found in coal miners, probably from the combined influence of insufficient light and of a constantly strained unnatural position of the eyes when at work. This latter form may be cured by change of employment, but ordinary nystagmus does not yield to treatment.

DISEASES OF THE ORBIT.

Periostitis usully affects the orbital margin, and is most common in strumous children; sometimes it is due to injury or syphilis.

Symptoms. — Dull pain, circumscribed swelling with redness, and much tenderness to finger pressure. At first the swelling is hard, but it usually softens later on the formation of pus, and on puncture bare bone may be detected by the probe. If the disease be deep in the orbit, the general symptoms are more severe, and the eye-ball is pushed forward or displaced laterally.

Course.—As a rule such cases do well, but sometimes deeply seated periostitis or caries may cause optic atrophy, or even endanger life by the inflammation spreading to the meninges or causing venous thrombosis.

Treatment.—Poulticing or hot fomentations. Early evacuation of pus. Constitutional treatment as indicated.

Orbital cellulitis.—*Symptoms.*—Proptosis and impaired movements of globe, conjunctival chemosis, redness and swelling of lids; severe localised pain and general fever. On pus forming, we find a circumscribed, fluctuating, conjunctival bulging. Sometimes we get optic neuritis, or even purulent choroiditis, and still more rarely we may have pyæmia or purulent meningitis.

Causes. — Wounds, spreading of inflammation from a neighbouring cutaneous erysipelas or from caries. Sometimes it is metastatic, as in splenic fever, glanders, or pyæmia.

Treatment.—As of last affection.

Tumours in this situation usually cause proptosis and impairment of ocular movements, and often lead to papillitis or optic atrophy. Both orbits are rarely affected. The *primary* tumours are cystic (dermoid, cysticercus), sarcomatous, bony (ivory exostosis), and vascular. In the vascular variety we usually get a bruit heard over the orbit and adjacent part of the skull, and often visible pulsation. The *secondary* tumours arise in the globe itself or in the neighbouring parts. Many of the vascular tumours here are intracranial in origin, the most common being arterio-venous aneurism from rupture of the internal carotid into the cavernous sinus, generally caused by fracture of the base of the skull.

Treatment. — Cysts may be evacuated by free incision (after needle puncture so as to eliminate the remote possibility of its being an encephalocele). Exostoses, when not attached to the thin upper wall, and when their base is narrow, may be removed. Malignant tumours should be removed early along with the eye-ball and all the orbital contents, and chloride of zinc paste then applied. In many vascular tumours ligature of the common carotid is advisable; digital compression may be tried as a preliminary.

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